UNIT 2: SURVEY OF HUMAN COMPUTER

INTERACTION PRACTICES

Contents

1.0 INTRODUCTION

Nature of Interactivity

Long ago going down memory lane, 'remote computer interaction' was done through *batch* processing involving punched card stacks or large data files prepared with long wait for the line printer output. And if it is not right the wait continued indefinitely ...

But now most computing is 'truly' interactive with rapid feedback and the user is in control most of the time with the thinking taken over by the computer.

A typical computer system interaction is carried out through input devices such as: the screen or monitor, keyboard, mouse or track pad.

The input devices exist in variations of desktop, laptop, mainframe computers and Personal Digital Assistants (PDAs). The devices dictate the styles of interaction that the system supports.

If we use different devices, then the interface will support a different style of interaction.

This unit sets out to remind you of the various nature of human-computer interaction that you may have normally come across.

In order to understand the nature of human—*computer* interaction, one needs to understand the computer systems.

2.0 OBJECTIVES

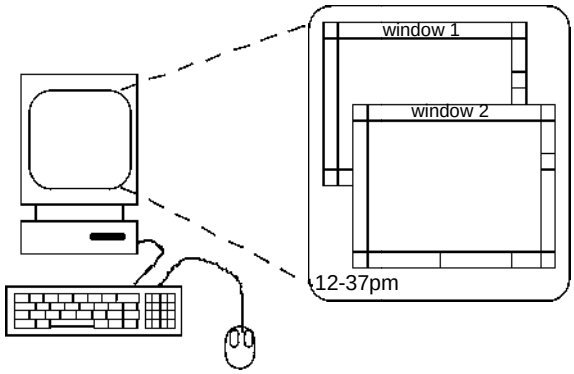
By the end of this unit, you should be able to:

- Understand handwriting and speech recognition
- Identify positioning, printing and drawing devices
- Know display devices
- Recognize physical controls and sensors
- Differentiate between printers and scanners
- Know memory and storage formats

3.0 MAIN CONTENT

3.1 Overview of the Computer System

The computer system is made up of various elements and each of these elements affects the interaction in the following manner:
Input devices are used for text entry and pointing.
Output devices are used for display and print of processed data on Visual Display Unit (screen) and printer on digital paper
Virtual reality affected using special interaction and display devices
Physical interaction carried out through sound, haptic, and bio-sensing devices Paper is used for printing output and for scanning inputs.
Storage and memory utilized through accessing large capacity Random Access Memory (RAM) and permanent storage media
Processing carried out using high speed processing units and networks see a pictorial representation below:



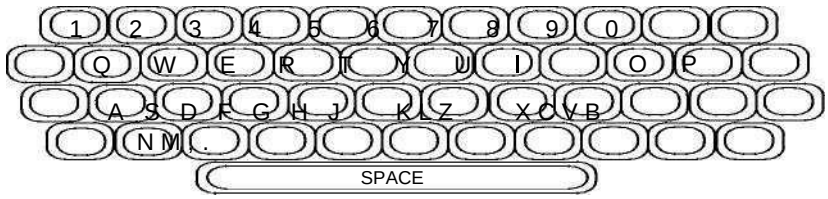
You can therefore consider the types and variations of computers that help operate your devices as follows:
In your house, these include
Personal Computers
TV, VCR, DVD, HiFi, Cable/satellite
TV Microwave, Cooker, Washing
Machine Central heating system
Security system
Can you think of more variations?

And then portable ones that can be put in your pockets
Personal Digital Assistants
Phone, Camera
Smart card and card with magnetic strip
Electronic car key with automatic opening and closing of
doors USB memory

3.2 TEXT ENTRY DEVICES

Most of these common text input devices allow rapid entry of text by experienced users and usually connected by cable but can also be wireless.
The richer interaction is enabled through faster text entry devices using 'QWERTY' keyboards, chord keyboards and phone pads

QWERTY layout



Standardized layout — QWERTY keyboard with non-alphanumeric keys are placed differently because accented symbols are needed for different scripts.
An example of QWERTY arrangement is shown above:
This QWERTY arrangement is not optimal for typing because initial layout was to prevent typewriters jamming! Alternative designs however allow faster typing but large social base of QWERTY typists produces reluctance to change.
Alternative keyboard layouts introduced later, have the following characteristics: Alphabetic:
Here the keys are arranged in alphabetic order but are however neither faster for trained typists nor for beginners too!

Dvorak:
This has common letters under dominant fingers with bias towards right hand.
Common combinations of letters alternate between hands resulting in 10-15% improvement in speed and reduction in fatigue.
Expectedly, large social base of QWERTY typists produce market pressures not to change.

Special keyboards:
These are designed to reduce fatigue for RSI and also for one handed use.

Example is the Maltron left-handed keyboard shown above. Chord keyboards:
These have only a few keys - four or five in number. Letters are typed as combination of key presses; the key presses reflect the letter shape.
Its compact size makes it ideal for portable applications.
It has a short learning time, and it is fast once you have trained. However, social resistance and fatigue creep in after extended use.

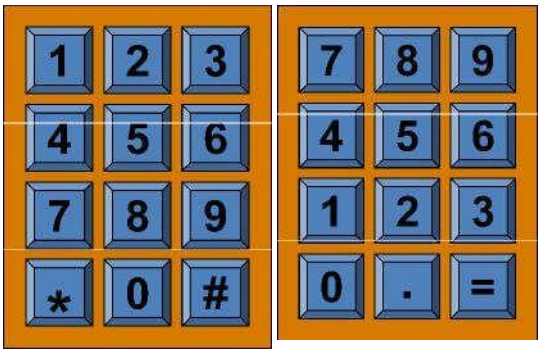
Phone pad and T9 entry:

These use numeric keys with multiple presses as shown above and keys extracted and shown

below 2 — a b c 6 - m n o
3- d e f 7 - p q r s4 - g h i 8 - t u v
5 - j k l 9 - w x yz

T9 predictive entry:
This allows typing as if single key for each letter. It uses dictionary to 'guess' the right word

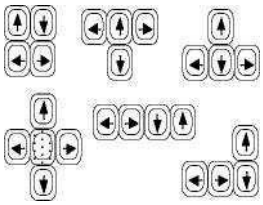
Numeric keypads
These are also developed for easier human computer interaction since they provide the means of entering numbers quickly. They could be found in calculators, PC keyboards and telephones.



Telephone Calculator

If you compare your phone keyboard with your calculator keyboard, you would notice the difference as shown above.

Cursor keys



There are four keys (up, down, left, right) on keyboard.
The keys are very, very cheap, but sl w and provide basic motion for text-editing tasks.
There is no standardized layout, but inverted "T" that is most common with discrete positioning controls.

3. 3 **Handwriting, Speech Recognition and other Devices**

3.3.1 Handwriting Recognition.

Another initiative that improves human interaction is Handwriting recognition.
Here text can be input into the computer, using a pen and a digesting tablet thereby producing natural interaction
However, this generates the following technical problems:
Difficulties may be experienced while capturing all useful information in a natural manner and segmenting joined up writing into individual letters.
Also difficult is interpreting individual letters and coping with different styles of and writing.
They are commonly used in PDAs (Personal Digital Assistants), and tablet computers.

3. 3.2 Speech Recognition:

This provides the advantage of leaving the keyboard on the desk, doing some other thing and talking to the computer!
The speech recognition is improving rapidly and is most successful when a single user has initial training and learns the peculiarities of limited vocabulary systems
The speech recognition system may have problems with
External noise interfering, imprecision of pronunciation, large vocabularies, and variation effects due to different speakers.

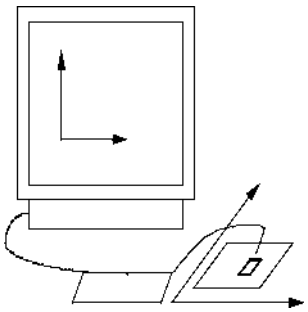
Other devices:
Other classes of human interaction devices are the positioning, pointing and drawing devices that include the mouse, touchpad, trackballs, joysticks, touch screens, eye gaze and

cursors.

3.4 **Positioning, Pointing and DrawingDevices**

The Mouse

This is a human computer interaction medium and is a handheld pointing device that is very common and easy to use. It has two characteristics, the planar movement and the buttons. Usually from 1to 3 buttons on top, used for making a selection, indicating an option, or to initiate drawing etc. The mouse is located on desktop and requires no large physical space and no arm fatigue.



Relative movement only is detectable which moves the screen cursor. The screen cursor is oriented in x and y plane while the mouse movement is in x and z plane...

It is an *indirect* manipulation device that does not obscure screen, it is accurate and fast. There are two methods for detecting its motion

Mechanical

- Ball on underside of mouse turns as mouse is moved rotating orthogonal potentiometers
- It can be used on almost any flat surface

Optical

- Here light emitting diode is located on underside of mouse
- It may use special grid-like pad placed on desk
- It is less susceptible to dust and dirt
- It detects fluctuating alterations in reflected light intensity to calculate relative motion in (x, z) plane
- It can be used even by foot using foot *mouse similar to* car pedals, sewing machine speed control, organ and piano pedals

Trackball and thumbwheels

A Trackball has a ball rotated inside a static housing like an upside down mouse! Its relative motion moves the cursor. It is an indirect device and fairly accurate using separate buttons for picking. It is very fast for gaming and used in some portable and notebook computers.

Thumbwheels are used for accurate Computer Aided Design (CAD). It has two dials for X-Y cursor positioning. For fast scrolling, a single dial is used on mouse.

Joystick and keyboard nipple

Joystick has an indirect pressure of stick that equals the velocity of movement. It has buttons for selection on top or on front like a trigger.
It is often used for computer games, aircraft controls and 3D navigation
A Keyboard nipple is useful for laptop computers. It has a miniature joystick in the middle of the keyboard.

Touchpad
These are small touch sensitive tablets with 'stroke' to move mouse pointer used mainly in laptop computers. It has 'acceleration' settings in form of fast stroke with lots of pixels per inch moved and initial movement to the target
Other types have slow stroke with less pixels per inch for accurate positioning.

Touch-sensitive screen
A touch-sensitive screen detects the presence of finger or stylus on the screen. It works by interrupting matrix of light beams, capacitance changes or ultrasonic reflections. It is a *direct* pointing device.

- Advantages are:
  - It is fast, and requires no specialized pointer
  - It is good for menu selection
  - It is suitable for use in hostile environment; being clean and safe from damage.
- Disadvantages:
  - Finger can mark the screen
  - It could be imprecise because the finger is a fairly blunt instrument!, hence difficult to select small regions or perform accurate drawing
  - The user lifting his arm can be tiring

Stylus and light pen
Stylus is a small pen-like pointer to draw directly on screen which may use touch sensitive surface or magnetic detection.
It is used in PDA, tablets PCs and drawing tables
Light Pen is now rarely used but uses light from screen to detect location.
Both stylus and light pen are very direct and obvious to use but they can obscure the screen.

Digitizing tablet
This is a mouse like-device with cross hairs used on special surface and it is rather like stylus.
It is very accurate and used for digitizing maps

Eye gaze
This controls interface by eye gaze direction such as looking at a menu item to select it. It uses laser beam reflected off retina at a very low power laser!
It is mainly used for evaluation and has potential for hands-free control.
Its high accuracy requires headset. The cheaper and lower accuracy devices are available under the screen like a small web cam.

Discrete positioning controls
These can be found in phones, TV controls etc.
They have cursor pads or mini-joysticks with discrete left-right and up-down movement used mainly for menu selection. See below.

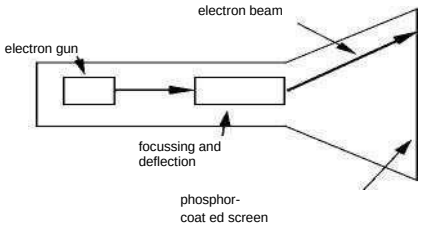
3.5 Display devices

These are bitmap screens Cathode Ray Tube (CRT) and Liquid Crystal Displays (LCD).There are also large and situated displays.

Bitmap Screen displays

The screen contains vast number of colored dots with the following resolution and color depth:
Resolution: This is the number of pixels on screen (width x height), for example SVGA has 1024 x 768, PDA has around 240 x 400.
Density of pixels (in pixels or dots per inch - dpi) is typically between 72 and 96 dpi
Aspect ratio: This is the ratio between width and height, for example ratio 4 to 3 for most screens, ratio 16 to 9 for wide-screen TV.
Colour depth: This expresses the number of different colours for each pixel. e.g. black and white or greys only, 256 from a palette, 8 bits each for red, green, and blue contains millions of colours.

Cathode Ray Tube (CRT)



Stream of electrons emitted from electron gun, focused and directed by magnetic fields, hit phosphor- coated screen which glows and used in TVs and computer monitors.

Health hazards of CRT!

X-rays are largely absorbed by the screen though not from the rear.
Ultra Violet and Intra Red radiations emanate from phosphors in the tube but at insignificant levels. Radio frequency emissions, plus ultrasound about 16kHz, are common.
Electrostatic field leaks out through tube to the user. The Intensity is dependent on distance and humidity and this can cause rashes to the user.
Electromagnetic fields between 50Hz and 0.5MHz create induction currents in conductive materials, including the human body. Two types of effects are attributed to this: effect on visual system with high incidence of cataracts in VDU operators, and concern over reproductive disorders such as miscarriages and birth defects.

Health hints...
Do not sit too close to the screen Do not use very small fonts
Do not look at the screen for long periods without a break. Do not place the screen directly in front of a bright window Work in well-lit surroundings
Take extra care if pregnant.
Also watch your posture, ergonomics and stress while using the system.

Liquid Crystal Displays (LCD)
This is smaller, lighter, and without radiation problems.
They are found on PDAs (Personal Digital Assistants), portables and notebooks, and increasingly on desktop and even home TV.
It is also used in dedicated displays such as in digital watches, mobile phones, High Fidelity (HiFi) controls etc.
How it works...
Top plate is transparent and polarized. Bottom plate reflects the light that passes through the top plate and crystal, and reflects back to user's eye. The voltage applied to the crystal changes polarization and hence the colour.
The light from the display is reflected and not emitted and so causes less eye strain.

Special displays of LCD
Random Scan comprising directed-beam refresh and vector display
These draw the lines to be displayed directly without jaggies. The lines need to be constantly redrawn. They are however rarely used except in special instruments

Direct view storage tube (DVST)
- Similar to random scan but persistent => no flicker
- Can be incrementally updated but not selectively erased
  - Used in analogue storage

oscilloscopes large displays
- Used for meetings, lectures, etc.
- technology
  - plasma — usually wide screen
  - video walls — lots of small screens together
  - projected — RGB lights or LCD projector
    - hand/body obscures screen
    - may be solved by 2 projectors + clever software
  - back-projected
- frosted glass + projector behind

Direct view storage tube (DVST)
Similar to random scan but persistent and has no flicker. It can be incrementally updated but not selectively erased
It is used in analogue storage oscilloscopes.
Has large displays used for meetings, lectures, etc.
The technology comprises plasma that is usually a wide screen. The video walls contain lots of small screens together and has projected RGB lights or LCD projector.

Situated displays
These are displays in 'public' places for a small group.
The display is only for information re the interactive one uses stylus and t meaning of information or interaction

3.6 Physical Controls, Sensors etc.

These are special displays and gauge controls, environmental and bio-sen

Dedicated displays like physical cont. Analogue representations that include Digital displays as identified in small Head-up displays found in aircraft co

Sounds
Sounds are beeps, bongs, clonks, why confirmation of actions e.g. key click

Touch, feel and smell devices otherw Here touch and feeling are important Also important in simulation that req However, current technology in text

BMW iDrive
This is used for controlling menus with options by feel.
It uses haptic technology from Imme

Physical Controls:
These are specialist controls
that exi See examples below.

Environment and bio-sensing
These are sensors all around us such

Car courtesy light — small switch on door
Ultrasound detectors — as in security and
washbasins. RFID security tags in shops
Bio-sensors are you for personal health as applicable in the use of iris scanners, measurement of body temperature, heart rate, galvanic skin response and blink rate.

3.7 Print Technology:

The following elements of interaction are provided by the print technology
Fonts, Page description, What You See Is What You Get (WYSIWYG), Scanning, Optical Character Reading (OCR) etc

Printing
This is an image made from small dots. It allows any character set or graphic to be printed. Critical features are resolution expressed in size, spacing of the dots in dots per inch (dpi). Speed is usually measured in pages per minute.
Types of dot-based printers
i. Dot-matrix printers: These use inked ribbon (like a typewriter). They have line of pins that can strike the ribbon hence dotting the paper.
Typical resolution is between 80 to 120 dots per inch (dpi)
ii. Ink-jet and bubble-jet printers
These work by sending tiny blobs of ink from print head to paper. Resolution is typically 300 dpi or more.
iii. Laser printers
These are like photocopiers: Here dots of electrostatic charge are deposited on drum, which picks up toner (black powder form of ink) rolled onto paper which is then fixed with heat.
Typically 600 dpi or more.

Printing (aspect of human computer interaction) in the workplace Shop tills:
Dot matrix printer uses same print head for several paper rolls; may also print cheques Thermal printers use special heat-sensitive paper, paper heated by pins makes a dot. Though of poor quality, printing is simple and maintenance is low.
They are used in some fax machines.

Fonts
Font is a particular style of text according to some examples given below;
Courier font, Helvetica font, Palatino font, Times Roman font, IIIITICIIIMITI (special symbol) Size of a font is measured in points (1 point is about 1/72"), about related to its height.

Pitch
Fixed-pitch: In this case, every character has the same width, e.g. Courier
Variable-pitched — some characters are wider e.g. Times Roman — compare the 'i' and the "m"
Sans-Serif or Serif :
Sans-serif contain square-ended strokes such as in Helvetica Serif these are characters with splayed ends such as in Times Roman or Palatino Readability of text
Lowercase: easy to read shape of words
UPPERCASE: better for individual letters and non-words e.g. flight numbers: BA79 3 vs. ba79 3
Serif fonts: helps your eye on long lines of printed text but sans serif is often better on screen

Page Description Languages
Useful when pages become very complex with different fonts, bitmaps, lines, digitized photos, etc. Description languages can convert all into a bitmap and send to the printer.
Using a page description language sends a *description* of the page for example, instructions for curves lines, text in different styles, etc. can be sent. It is like a programming language for printing!
PostScript is the most common form of Page description language

3.8 Scanners

These accept paper and convert it into a bitmap Two sorts of scanner exist:
Flat-bed: Here paper is placed on a glass plate with whole page converted into bitmap Hand-held: Here scanner is passed over paper, digitizing strip typically 3-4" wide Shines light at paper and note intensity of reflection with colour or greyscale
Typical resolutions are from 600-2400 dpi
Scanners are used in desktop publishing for incorporating photographs and other images.
They are used in document storage and retrieval systems thereby doing away with paper storage. Special scanners exist for slides and photographic negatives

Optical Character Recognition (OCR):
Optical character recognition (OCR) converts bitmap back into text with different fonts creating problems for simple "template matching" algorithms.
However, more complex systems segment text, decompose it into lines and arcs, and decipher characters that way.
Page formatting is done on columns, pictures, headers and footers.

Paper-based interaction
Paper is usually regarded as *output* only but can be *input* too in OCR, scanning, etc. operations.
Xerox Paper Works is a paper based interaction that involve glyphs containing small patterns of /WW//WWW Used to identify forms etc. and also used with scanner and fax to control applications
More recently, papers are micro printed - like watermarks. Watermarks identify *which* sheet and *where* you are.
Special 'pen' can read locations to know where they are writing.

3.9 Memory Interaction

Exists in form of short term and long term
One needs to have knowledge of the characteristics of a particular memory for an effective and valuable interaction. Such include the speed, capacity, the compression formats and mode of access.
Short-term Memory
Short-term Memory otherwise called Random access memory (RAM) are made of silicon chips.
Most RAMs have 100 Nano-second access time and are usually volatile, losing information if power is turned off.
Data transfer rate is around 100 Mbytes/sec
Some *non-volatile RAMs (ROMs) are* used to store basic set-up of information typical desktop computers have between 64 to 256 Mbytes of RAM.
Long-term Memory
These include magnetic disks comprising:
i. Floppy disks that can store up to 1.4 Mbytes and more; hard disks that can store between 40 Gbytes to hundreds of Gbytes

Access time approximate to 10 micro seconds while transfer rate is around 100kbytes per second.

ii. Optical disks that use lasers to read and sometimes write. They are more robust that magnetic media. They include CD-ROMs that have same technology as home audio, with storage capacity approximating 600 Gbytes and DVDs used for AV applications and for very large files.
iii. PDAs (Personal Digital Assistants) that often use RAM for their main memory.
iv. Flash-Memories used in PDAs, cameras etc.. They are silicon based but persistent. Flash memories are Plug-in USB devices used for data transfer.

Virtual memory

Problems calling for the use of virtual memory include running lots of programs. Each program could be very large but with insufficient RAM size to run it, hence the need for the use of Virtual memory.

The solution provided by Virtual memory is to store some programs temporarily on disk thereby making RAM appear bigger. But the program on disk that needs to run again and copied from disk to RAM slows down processing.

Compression

This is the reduction in the amount of storage required. The two types that could be identified are: Lossless compression:

i. Here, the exact text or image is recovered e.g. as in GIF, ZIP formats.
ii. By looking for commonalities in text as demonstrated below:
iii. If text= AAAAAAAAAABBBBBCCCCCCCC then there are 10 As,5 Bs, and 8 Cs and is written as 10A5B8C
iv. Video: Here successive frames are compared and changes are stored. Lossy compression: This recovers something like the original — e.g. as in JPEG and MP 3 formats. Exploited perception:

In JPEG, perception is exploited by losing rapid changes and some colour while in MP 3, Z reducing accuracy of drowned out notes

3.10 Storage formats Text formats:

ASCII : This is a 7-bit binary code that represents each letter and character UTF-8 : This is an 8-bit encoding of 16 bit character set

RTF (rich text format): This is a text plus formatting and layout information

SGML (standardized generalised mark-up language): These are documents regarded as structured objects XML (extended mark-up language): This is a simpler version of SGML for web applications

Media formats:

Many storage formats exist for images: Such formats include PostScript, GIFF, JPEG, TIFF, PICT, etc. in addition to different compression techniques that reduce their storage requirements.

For Audio/Video, there are lots of formats as well. Such include QuickTime, MPEG, WAV, etc... Compression is even more important here to optimize available storage space.

For network delivery of data, 'streaming' formats are also available. Methods of access:

For any of the data type above, a large information store takes long time to search. Therefore, an index storage technique is used. Whatever is indexed is what can be accessed. Simple index needs exact match. Accessing without structure involves free text indexing all the words in a document hence requires lots of space!!

3.11 Processing and Networks Interactions

i. Clicks on an icon and nothing happens, clicks on another, then system responds and windows fly everywhere.

ii. Also problems do occur if system is too fast. For example, help screens may scroll through text much too rapidly to be read.

Moore's law
The Moore's law observes that computers get faster and faster!
In 1965, Gordon Moore, co-founder of Intel, noticed a pattern that processor speed doubles every 18 months e.g.
PC in1987, speed was 1.5 MHz, up till 2002 when the speed became 1.5 GHz.
Similar pattern also occurs for memory and storage. But this doubles every 12 months!! E.g. Maximum Hard disk requirement in 1991 was 20 Megabytes but rose in 2002 to 30 Giga bytes

The myth of the infinitely fast machine:
The implicit assumption here is that there are no delays in processing on an infinitely fast machine. This takes us to the question: What is a good design for real machines?

Networked computing
Networks allow access to large memory and processing, access to other people (such as in groupware and email) and other shared resources especially the web
Issues relating to interaction in network computing are network delays which cause slow feedback, and unexpected processing delay as a result of many people updating data simultaneously.
Lastly is the unpredictability nature of networks.

The internet as an example of a network, (international network of computers) Short History:
In 1969: DARPANET US Department of Defence had 4 sites. In 1971, the sites increased to 2 3. In 1984, it became 1,000 and in 1989, it increased to 10,000 .
Common language protocols used are:
i. TCP — Transmission Control protocol: This operates at lower level on packets (like letters) between machines.
ii. IP — Internet Protocol: This provides a reliable channel (like phone call) between programs on machines. Email and HTTP (Hypertext Transmission Protocol) build on top of these.

4.0 **Conclusion**

In spite of all the discussions about the various interactions above, some limitations are placed on interactive performance as follows:
Computation bound: Computation may take a long time, causing frustration for the user.
Storage channel bound: Bottlenecks may occur in the transference of data from disk to memory. Graphics bound: Here common bottleneck is that updating displays requires a lot of effort, effort sometimes helped by adding a graphics co-processor optimized to take on the burden
Network capacity: Though many computers are networked with sharable resources and files and access to printers etc. yet still have interactive performance reduced by slow network speed.

5.0 **Summary**

The knowledge of the computer systems and the types of user interface devices such as the text entry, hand writing and speech recognition, pointing and drawing, display and storage together with the kind of network facilities have their individual impacts on human computer interactions.

6.0 Tutor Marked Assignment

1. What is the reason for the difference in the arrangement of Numeric keypads existing between your phone keyboard and the calculator keyboard
2. What are the specific difficulties experienced in handwriting recognition as a human interaction medium
3. Mention 2 advantages and 2 disadvantages of the touch sensitive screen interface
4. Explain the characteristics of the eye gaze interaction.
5. Mention 5 health hazards that may likely exist as a result of interacting with the CRT
6. (a) What do you know of haptic devices and biosensors?
(b) Describe the function and value of Page Description language
7. What is Virtual memory and its benefit in Computer processing?

7.0 Further Readings / References

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