

Assignment - 1

Human - Computer Interaction

1 Explain human I/O channels with examples

→ Human - Computer Interaction (HCI)

Studies how humans communicate with computers. For this purpose, it is important to understand human input and output channels, which are the basic pathway through which humans receive information from the environment (input) and express themselves to the environment (output).

1 Human input channels

i Visual channel

- The eyes are the most powerful sensory input.
- Users gather information such as text, icons, colors, shapes, and movement.
- For Ex, Reading text on a computer screen or noticing red color for an error message.

ii Auditory channel

- The ears help in receiving sounds, speech and tones.
- Computers use this channel through alarms and voice outputs.
- For Ex, Notification sounds on a mobile phone or voice commands in virtual assistants like Alexa.

iii Haptic (Touch) channel

- The skin senses pressure, temperature, and texture.
- Computers interact via touch screens, vibration feedback, or haptic devices.
- For Ex, Feeling vibration in a game controller or using multi-touch gestures on smartphone.

iv. Olfactory and Gustatory channels (less used in HCI)

- Smell and taste are not commonly used in computing, but they are input channels for humans.
- For Ex, special simulators for training

2 Human Output channels

i Speech channel

- Humans communicate using spoken language
- Computers can capture speech through microphones and speech recognition systems.
- For Ex: Giving voice commands to Siri or Alexa

ii Motor Movement (Hands, Arms, Body)

- Humans use hands to control keyboards, mice, joysticks, or touchscreens.
- Eye and head movements can also be used for interaction.
- Ex. Typing on a keyboard, dragging objects with a mouse, or using gesture recognition with Kinect.

iii Facial Expressions and Emotions

- Output can also be expressed non-verbally using expressions.
- Modern HCI systems attempt to detect emotions through cameras.
- Ex. Emotion recognition in AI-based chat systems

2 Explain the concept of paradigms in HCI

- In HCI, a paradigm refers to a set of concepts, methods, and technologies that guide how humans interact with computers.
- It represents a model or style of interaction that influences system design and user experience.
- 1. Time-sharing paradigm (1960s)
 - Many users share one computer simultaneously
 - For Ex, Mainframe computers with terminals
- 2. Personal computing paradigm (1970s - 80s)
 - One computer per user, personal productivity focus.
 - For Ex, Desktop PCs with GUI
- 3. Networking & Internet paradigm (1990s)
 - Computers interconnected! focus on communication and sharing.
 - For Ex, Email, web browsing
- 4. Mobile & Ubiquitous computing paradigm (2000s)
 - Access anytime, anywhere; devices are portable and embedded.
 - For Ex, Smartphones, tablets, IoT devices.

3 Discuss Sensory Memory, short-Term, and Long Term Memory in detail.

1] Sensory Memory

- Sensory memory is the very brief storage of information from the senses (sight, sound, touch, etc.) immediately after the stimulus is experienced.
- Extremely short-lived (less than 1 second for vision, 2-3 seconds for hearing)
- Very high capacity, but information quickly fades if not attended to.
- Iconic Memory (visual) :- stores visual images for a fraction of a second.
- Echoic Memory (Auditory) ! stores sound information for a few seconds.

2. Short-Term Memory (STM)

- STM, also called working memory, temporary stores and manipulates information that is actively being used.
- It remembers about 15-30 seconds without rehearsal

- Limited capacity, around 7 ± 2 chunks according to Miller's Law
- For STM information must be rehearsed, or it will be lost.
- Chunking helps expand capacity. It plays a central role in problem solving and decision-making.

3] Long-Term memory

- LTM stores information for extended periods of time, often permanently.
 - Capacity of LTM is potentially 1 month to lifelong. Very large capacity, virtually unlimited.
1. Episodic Memory :- Stories personal experiences
 2. Semantic Memory :- Stories facts and knowledge
 3. Procedural Memory :- Stories skills and actions.

4 Discuss GOMS Model in detail.

- The GOMS model is cognitive modeling technique in HCI.
- It is used to analyze and describe the user's behavior when interacting with a system in terms of their Goals, Operators, Methods, and selection rules.
- GOMS helps in predicting user performance, task completion time, and usability problems before the system is fully developed.

1. G :- Goals

- The objectives a user wants to achieve
- For Ex, send an email, withdraw cash from atm.

2. O : Operation - Operators

- Basic actions the user performs to accomplish goals.
- For Ex, clicking a button, typing a word

3. M :- Methods

- Procedures or sequences of operators used to achieve a goal.
- For Ex, To copy text, method could be:-
Select text → Press $Ctrl + C$

4 S- Selection Rules

- Rules that decide which method to use when multiple methods exist.
- For Ex, A user may either use **ctrl + C** or right click → **Copy** depending on habit.

* Types of GOMS Models

1. CMN = GOMS (classic)

→ The original model, describes tasks hierarchically.

2. NQOMSL (Natural GOMS Language)

→ A structured, pseudo-code like version for easier description.

3. KLM (Keystroke-Level Model)

→ Predicts time taken for tasks by focusing on low level physical actions like key strokes, mouse clicks and pointing.

5 Explain stakeholders. Explain Primary, Secondary and tertiary stakeholders with examples.

→ In HCI, stakeholders are all the people or groups who are directly or indirectly affected by a system's design, development, and use.

1. Primary stakeholders

- These are the people who directly interact with the system on a regular basis. Their performance and satisfaction depend heavily on the system's usability.
- For Ex, students using an e-learning platform, End user of a mobile banking app.

2. Secondary stakeholders

- People who do not directly use the system but are affected by the output, results, or decisions made through the system. They rely on system generated information to carry out their tasks.
- For Ex, A teacher who checks reports generated from an e-learning system.

3 External Stakeholders

- People who are indirectly affected by the system or have an interest/influence in its success but don't use the system directly
 - They may set policies, provide support, or be impacted socially/economically by the system.
- For Ex, parents of students using an e-learning app (they don't use it, but they care about performance)

6 Discuss Task Action Grammar (TAG) with example.

- TAG is a cognitive model in HCI that explains how users translate their goals into actions when interacting with a system.
- TAG describes how tasks (user goals) are decomposed into actions (physical operations on the system), following a grammar-like structure.
- Just like natural languages have grammar rules (syntax + semantics),
 - Tasks = sentences
 - Actions = word/phrases
 - Rules = grammar of interactions.
- Steps in TAG
 1. Goal Identification - The user recognizes what they want to achieve.
 2. Task Specification - The goal is broken into smaller tasks
 3. Action Mapping - Each sub-task is converted into system actions
 4. Execution - The user performs the actions in sequence.

* For Ex, ATM withdrawal

1. Goal (task) : withdraw 1000 Rs.

2 Task Specification

- i. Insert card
- ii. Enter PIN
- iii. choose withdraw
- iv. Enter amount.
- v. Collect money

3 Actions

Insert card → Physical slot action

Enter PIN → Keypad press (constraint: "4 digits")

choose withdraw → Touch screen option

Enter amount → keypad input.

Collect money → Take cash from dispenser.

7 Discuss keystroke Level Model (KLM) in details

- The Keystroke Level Model (KLM) is a predictive model in HCI used to estimate how long it takes an expert user to complete a task on a computer.
- KLM focuses specifically on low-level actions like keystrokes, mouse clicks, and pointing movements.

• KLM Operators

K	Keystroke or button press	0.20s
P	Pointing with a mouse to a target on screen	1.10s
H	Homing - moving hand between keyboard and mouse	0.40s
M	Mental preparation before next action	1.35s
R(t)	System response time	Depends on sys
B	Button press with CofTen included with *	0.10s

• Steps in Applying KLM

1. Identify the task (e.g. saving a file in Ms Word)
2. Break it into a sequence of primitive operators
3. Assign times to each operator.
4. Add them up → total predicted task time.

- Example: saving a file with keyboard shortcuts

Task: save a file using $\text{ctrl} + \text{s}$

1. M - mentally prepare to save (1.35s)
2. K - Press ctrl (0.20s)
3. K - Press s (0.20s)
4. R - Wait for system response (~0.50s)

$$\begin{aligned}\text{total} &= 1.35 + 0.20 + 0.20 + 0.50 \\ &= 2.25 \text{ seconds.}\end{aligned}$$

Q Explain Buxton's 3-state Model with example

- The state Model was proposed by Bill Buxton to describe the different interaction states of input devices (like mouse, stylus, touch)
- It explains how devices sense input and change states depending on whether they are idle/tracking or performing an actions.

1. State 0 - Out of Range (Idle)

- Device is not interacting with the system.
- For Ex, Mouse not touching the surface/stylus lifted from tablet.

2. State 1 - Tracking

- Device is being tracked, but no action is performed.
- For Ex, Moving mouse on pad → cursor moves.

3. State 2 - Dragging / Action

- Device is both tracked and an action is being performed.
- For Ex, Holding mouse button + moving → drag operation.

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- Ex. Using a mouse

state 0 : Mouse is lifted from the desk →
System does not detect movement.

state 1 : Mouse on desk → cursor moves
with "mouse" movement

state 2 : User presses and holds left button
while moving → dragging a file / folder.

Assignment - 2

1 Discuss virtual environment and immersive interaction in HCI.

- In HCI, virtual environment refers to computer-generated, interactive 3D worlds that simulate real or imaginary settings.
- Immersive interaction means making the user feel as if they are truly inside that environment, fully engaged, with minimal distraction from the physical world.
- Virtual Environments (VE)
 - A Virtual Environment is a space created digitally where users can interact with objects, avatars, and surroundings in real time.
 - It can mimic the real world (e.g. driving simulators) or create fantasy worlds.
- Immersive Interaction
 - Immersion refers to the degree to which a user feels present in the virtual environment.

- Achieved using special hardware and software that engage multiple human senses
 - level of immersion
1. Non-immersive
 - Interaction through standard devices.
 2. Semi-immersive
 - Large screens, 3D projections, or limited VR headsets.
 3. Fully immersive
 - Head mounted displays, motion tracking, haptic gloves..

2 Explain interaction Different types of Interaction styles with examples.

→ Interaction in HCI refers to the way a user communicates with computer system to achieve a task.

→ The choice of interaction style affects usability, efficiency, and user satisfaction.

1. CLI (Command Line Interface)

→ User types commands using a keyboard.
→ For Ex, Typing dir in windows, CMD to list files.
Using ls in linux.

2. Menu Selection

→ User selects from a set of pre-defined options.
→ For Ex, Drop-down menus in MS Word.

3. Form Fill-in

→ User enters data into labeled fields.
→ For Ex, Online registration forms

4. Direct Manipulation

→ User interacts directly with visual representation.
→ For Ex, Dragging a file to recycle bin in windows

3 compare the use of form fillings and dialog boxes with examples

Form Filling

- User enters data into structured fields.
- Collects large amounts of structured information.
- Online registration form, railway booking form; loan application form.
- ^{effort} High = user must fill multiple fields.
- Flexible input (text, numbers).
- Long interaction length, requires multiple steps

Dialog Boxes

- Small pop-up window that asks for confirmation or provides feedback.
- Handles quick decisions, warnings, or confirmations.
- Sure changes before exit, confirm delete, low battery warning.
- Low - usually one click or simple choice.
- Limited to predefined options (Yes/No.)
- Short interaction length, immediate interaction.

4 Explain Donald Norman's model in detail.

→ Donald Norman, a cognitive scientist, proposed a model of interaction that explains how users interact with systems and how designs can reduce the gap between what users want and what systems provide.

1. Forming the goal

- The user decides what they want to achieve.
- For Ex. A student wants to print a document.

2. Forming the intention

- The user decides how to achieve the goal.
- For Ex. I will print by selecting the print option from the file menu.

3. Specifying the Action sequence

- User identifies steps required to execute the intention.
- For Ex. click File → Print → OK

4 Executing the Action.

- User actually performs the actions.
- Ex. student clicks on File → print → OK

5 Perceiving the system state

- User observes how the system responds.
- For Ex. The printed dialog box appears, and printing starts.

6. Interpreting the system state

- User interprets the system's feedback.
- For Ex, The System shows printing... status → User understands the document is being printed.

7 Evaluating the outcome

- User compares the outcome with original goal.
- For Ex, User checks whether the document was actually printed.

• Two CUIF in Norman's model

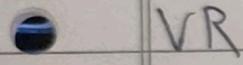
1. CUIF of Execution
2. CUIF of Evaluation

5 Discuss interaction devices for VR and AR system

→ Interaction devices are hardware and tools that allow users to interact naturally with virtual or augmented environments.

1. Head-Mounted Displays

→ VR HMDs :- Oculus Quest, HTC Vive, PlayStation VR



→ AR HMDs :- Microsoft Hololens, Magic Leap. Provides stereoscopic 3D visuals.

2. Motion Controllers

→ Handheld devices with sensors and buttons

→ Detect hand position, orientation, and gestures.

→ Often include haptic feedback for realism.

3. Gloves and Wearables

→ Data gloves : capture fine-grained finger movements.

→ Haptic gloves : provide tactile feedback

4. Eye and Gaze Tracking

→ Detect where the user is looking. Enable forecast rendering.

→ Used for natural interaction like selecting menus by looking at them.

6 Discuss Groupware and its applications in collaboration.

→ Groupware is software designed to help people working in teams collaborate, communicate, and coordinate their activities effectively, often regardless of physical location.

→ It supports sharing information, managing projects, and decision-making in group settings.

→ Sometimes called collaborative software tools.

• Types of Groupware

1. Communication Tools

→ Help exchange messages in real-time or asynchronously.

2. Coordination Tools

→ Manage tasks, schedules, and workflows.

3 Collaboration Tools

→ Allow multiple users to work on shared documents or projects.

7 Explain ubiquitous computing and augmented reality with examples.

- Ubiquitous computing means "computing everywhere, anytime, in the background".
- It integrates computers into everyday life so naturally that users don't even notice them.
- The technology works seamlessly and invisibly in the environment.

1. Invisibility :- Devices blend into surroundings.
2. Context Awareness :- Systems adapt to user's situation.
3. Pervasiveness :- Computing available everywhere, not just on desktops.
4. Ease of use :- Minimal effort needed by user.

- Augmented Reality overlays digital information onto the real-world environment.
- Unlike VR which fully immerses AR enhances reality rather than replacing it.

1. Combines real and virtual elements.
2. Real-time interaction.
3. 3D registration - digital objects appear aligned with real world objects.

8 Explain hypertext, multimedia, and www as interaction platforms.

→ Hypertext is a system of non-linear text that allows users to navigate between related pieces of information using links.

1. Non-linear navigation - users can jump to different sections.
2. Links - connect related documents or sections.
3. User-controlled browsing - freedom to explore.

ii Multimedia as an interaction platform

→ Multimedia combines text, images, audio, video, animation and graphics into a single interface to make communication more engaging.

1. Multi-sensory - appeals to both visual and auditory senses
2. Interactive - users can play, pause, control media.
3. Rich experience - information presented in attractive ways.

III WWW (World Wide Web)

→ The WWW, created by Tim Berners-Lee in 1989, is a global system of interconnected documents and multimedia.

1. Universal access - available anywhere with internet.
2. Hyperlinks - connect billions of documents.
3. Multimedia support - text, images, video etc.