Week 13 Lecture: Emerging & Specialized Interface Types

Learning Objectives

1. Explore **advanced gesture, haptic, and voice-based interfaces**
2. Understand **AR, VR, and Mixed Reality (MR)** in HCI
3. Learn about **tangible interfaces** and **wearable technology**
4. Recognize design implications for **future UI trends**

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1. Advanced Gesture Interfaces

- **3D Gestures**: Detected via depth sensors (e.g., Microsoft Kinect, Leap Motion)
- **Mid-air gestures**: Touchless interactions for hygiene or convenience
- **Strengths:**
  - Useful in sterile or hands-busy environments (e.g., surgery)
  - Can be combined with AR/VR for immersion
- **Challenges:**
  - Fatigue from prolonged arm use ("gorilla arm")
  - Variability in gesture recognition due to lighting or occlusion
- **Design Tips:**
  - Keep gesture vocabulary small and distinct
  - Provide **real-time feedback** when a gesture is recognized
  - Offer fallback control methods (voice, buttons)

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2. Advanced Haptic Interfaces

- Goes beyond simple vibration:
  - **Force feedback** (e.g., racing wheel resistance)
  - **Texture simulation** (e.g., haptic touchscreens)
  - **Temperature simulation** in VR gloves
- **Use Cases:**
  - Gaming (realistic feel of objects)
  - Medical simulation (surgical training)
  - Accessibility (tactile feedback for blind users)
- **Design Tips:**
  - Match feedback to real-world expectations
  - Avoid excessive or prolonged feedback that can cause discomfort

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3. Voice Interfaces (VUI)

- Systems that use speech as primary input (e.g., Siri, Alexa)

- **Strengths:**
  - Hands-free, eyes-free interaction
  - Can be faster for certain tasks (setting reminders)
- **Limitations:**
  - Struggles with noisy environments
  - Accents, speech impairments, and language limitations
- **Design Tips:**
  - Use short, natural commands
  - Provide visual or auditory confirmation
  - Allow users to review/undo actions

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4. AR, VR, and Mixed Reality Interfaces

- **AR (Augmented Reality)** – Overlays digital info onto real-world view (e.g., Pokémon GO)
- **VR (Virtual Reality)** – Fully immersive virtual environment (e.g., Oculus games)
- **MR (Mixed Reality)** – Interactive blending of virtual and physical worlds
- **Strengths:**
  - High engagement, immersive learning/training
  - Supports spatial interaction
- **Limitations:**
  - Requires specialized hardware
  - Can cause motion sickness
- **Design Tips:**
  - Avoid clutter in AR overlays
  - Minimize latency in VR to prevent sickness
  - Consider real-world safety

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5. Tangible User Interfaces (TUI)

- Interaction through **physical objects** that represent digital data
- **Examples:**
  - Interactive museum exhibits
  - Smart tabletop displays
- **Strengths:**
  - Intuitive and engaging
  - Good for collaborative or educational settings
- **Challenges:**
  - Hardware costs, durability
- **Design Tips:**
  - Ensure mapping between object and function is clear
  - Provide feedback when objects are moved or used

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6. Wearable Interfaces

- Devices worn on the body that provide interaction and feedback
- **Examples:** Smartwatches, fitness trackers, AR glasses
- **Strengths:**
  - Always accessible
  - Supports context-aware notifications
- **Limitations:**
  - Small screen real estate
  - Battery constraints
- **Design Tips:**
  - Prioritize glanceable information
  - Use haptic and audio cues for alerts

Summary Table

Interface Type	Strengths	Limitations	Design Tip
Advanced Gesture	Touchless, immersive	Fatigue, recognition errors	Keep gestures simple, confirm recognition
Advanced Haptic	Realistic feedback, accessibility	Can cause discomfort	Match to real-world expectations
Voice (VUI)	Hands-free, natural input	Noise, accents	Short commands, feedback confirmation
AR / VR / MR	Immersive, engaging	Hardware cost, motion sickness	Avoid clutter, minimize latency
Tangible (TUI)	Physical, intuitive	Expensive, bulky	Clear mapping between object and action
Wearables	Always available, context-aware	Small display, battery limits	Focus on glanceable info, haptic alerts

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Week 13 – Review Exercises for *Emerging & Specialized Interface Types*.

Section A: Multiple Choice

1. Which type of haptic feedback simulates resistance, such as in a steering wheel?
A) Vibration feedback
B) Force feedback
C) Texture simulation
D) Temperature simulation

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2. What is the main advantage of **mid-air gesture interfaces** in medical environments?
A) They are faster than touch interfaces
B) They work without visual feedback
C) They allow hands-free interaction without physical contact
D) They reduce fatigue compared to touch

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3. Which technology blends real and virtual elements into a single interactive environment?
A) Augmented Reality (AR)
B) Virtual Reality (VR)
C) Mixed Reality (MR)
D) Tangible User Interfaces (TUI)

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4. Which of the following is NOT a limitation of wearable interfaces?
A) Battery constraints
B) Small display size
C) Always being accessible
D) Limited processing power

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5. Tangible User Interfaces are best suited for:
A) Voice-driven AI assistants
B) Interactive physical exhibits
C) Mobile-first social media apps
D) Text-based coding environments

Section B: Short Answer

1. Give an example of a real-world application for **advanced haptic feedback** and explain how it improves user experience.

2. Compare AR and VR in terms of immersion and hardware requirements.

3. What is one advantage and one disadvantage of using **voice interfaces** over gesture interfaces?

4. How can **wearable devices** use haptic alerts effectively without being disruptive?

5. In Tangible User Interfaces, why is it important to provide feedback when a physical object is moved or manipulated?