Exploring Human-Computer Interaction (HCI) concepts and Novel Interaction Technologies

Abdul-matin Adebayo
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INTRODUCTION

In many areas like education, healthcare, and entertainment, new ways to interact are becoming more and more popular. Users can interact with digital interfaces in new ways with these technologies because they used advanced interfaces. For instance, virtual and augmented reality technologies let people live in a digital world and connect with things in real-time. Other technologies, like natural language processing and gesture detection, let people use their voices and body movements to interact with computers.

The use of novel interaction technologies has made a significant difference in how well students learn, especially in STEM (science, technology, engineering, and math) areas (Huang and Li, 2020). Similarly, virtual reality and augmented reality are being used in the entertainment sector to provide users with more immersive experiences (Bystrom et al., 2021)

TECHNOLOGY SUMMARY

In this module, we will explore various ranges of novel interaction technologies that enable users to interact with information. Additionally, we will examine the use and applications of standard Human-Computer Interaction (HCI) concepts. Some of the major novel interaction technologies to be explored include:

- Tangible User Interfaces
- Ubiquitous Computing
- Augmented Reality
- Haptic Interaction
- Proxemic Interaction

Tangible User Interfaces:

Tangible User Interfaces (TUIs) are a type of interface that allows users to interact with digital information through physical objects. These physical objects represent digital information, making it easier for users to manipulate and understand the data (Shaer & Hornecker, 2010). It makes use of people's physical abilities and gives physical form to digital information.

Examples of Tangible User Interfaces

- The Marble Answering Machine.
- Tabletop Interfaces, such as the Reactable, where physical objects placed on a surface control and manipulate digital information.
- Tangible musical instruments, make use of physical objects to create and manipulate music.

Some challenges of TUIs are:

- The lack of a standardized set of designs for TUIs can make it difficult for designers to create consistent and effective interfaces.
- Designing parallel and continuous interaction

Ubiquitous Computing:

Ubiquitous computing is the concept of embedding computing devices into everyday objects, allowing for easy interaction between physical and digital words and improving the potential usage of those objects. This technology gives users new ways to connect with their surroundings, such as by using gestures or voice commands.

Examples of Ubiquitous Computing:

- Smart Homes and IoT
- Smart Cities
- Healthcare monitoring devices

Augmented Reality:

Augmented Reality (AR) is a technology that adds digital items or information to the real world. This technology lets people connect with digital objects and information as if they were part of the real world (Milgram & Kishino, 1994). Augmented reality has gained mass adoption over the years, and is generally used to enhance users' perception of reality.

Use Cases:

Some AR use cases are:

- Product design and prototyping using AR, helping product designers visualize and test product concepts in the real world.
- Enhancing customer experience by providing interactive product demonstrations.
- AR can also be used in reducing perceived risks in online shopping, providing users with virtual try-on and personalized shopping experiences.

As AR technology develops and becomes more widely used, we can expect to see even more innovative use cases emerge in the coming years (Grand View Research, 2021).

AR Development Platforms:

Many AR development tools can be used to develop AR applications. The following are some examples:

- Vuforia
- Unity
- ARCore

Haptic Interaction:

Haptic Interaction is the use of touch and force feedback to allow people to interact with digital information more physically. Haptic Interaction is used in many sectors, like virtual reality, the gaming industry, and healthcare.

Examples of Haptic Interaction

- Virtual Reality: A haptic feedback system can simulate the sensation of touching virtual objects, providing a more realistic and immersive experience (Van Erp, 2002).
- Vibro-tactile displays can be used to give haptic feedback in gaming, enhancing the user's experience and immersion in the game. (Van Erp, 2002).

Proxemic Interaction:

Proxemic Interaction is a type of interaction that focuses on the relationship between people and the physical space around them. It enables users to interact with digital information and media using body movements and gestures.

Examples of Proxemic Interaction

- Wearables: Proxemic interaction can be used in wearables, such as smartwatches, to detect the movement of a user's arm and trigger events accordingly.
- Mobile devices may have proximity sensors to detect when a user is holding the device to their ear during a phone call and instantly turn off the screen.

COMPARISON

This section outlines a systematic comparison between each technology by identifying a set of criteria on which each technology would be assessed.

Overall, these novel interaction technologies are advancing the field of human-computer interaction, enabling users to interact with digital content in more natural and intuitive ways.

Criteria for Comparison

- Usability: Indicates how easy it is for users to interact with the technology.
- Immersion: How well the technology immerses the user in an experience.
- Interactivity: How much control users have over the experience.
- Portability: How easy it is for users to move and use the technology in different locations.
- Realism: How realistic is the experience provided by the technology?

The technologies would be assessed against these criteria and would be rated on a scale of 1 to 5, with 5 being the highest rating:

The table below indicates the representation of the systematic comparison between these technologies against the criteria listed above:

Technology	Usability	Immersion	Interactivity	Portability	Realism
Tangible User Interfaces	4	3	4	2	3
Ubiquitous Computing	5	4	4	5	4
Augmented Reality	4	5	4	4	4
Haptic Interaction	3	4	3	3	3
Proxemic Interaction	4	3	3	3	3

Table 1. Systematic Comparison of Novel Interaction Technologies

APPLICATION

This section outlines how the technologies in the previous sections can be used to design the given problem scenarios listed below:

- An interactive educational activity
- Digital technology to enhance the experience of museum exhibits.

An Interactive Educational Activity:

Design Idea:

In this section, we will explore a design idea, which is:

'An Interactive Dictionary', a voice command software that allows computer science students to search for phrases, and code concepts used in the field of computer science.

Features:

- Voice control for hands-free interaction with the dictionary with the functionality to search using voice commands.
- A comprehensive database of computer science-related concepts and definitions.
- Feedback and suggestion options for continuous improvement.

Application of Novel Technologies to this Design:

Tangible User Interfaces: Tangible User Interfaces could be used to give the dictionary a real way to be used. For example, a set of physical cards could represent different groups of words, and students could use voice commands to select and interact with the cards.

Ubiquitous Computing: Ubiquitous Computing could be used to make the dictionary available on multiple devices, allowing for ease of accessibility to students.

Augmented Reality: Augmented Reality could be used to give more visual information about terms and ideas in the dictionary. For example, students could point their device's camera at an object or code snippet, and the dictionary could overlay relevant definitions and explanations on the screen.

Haptic Interaction: Haptic Interaction could be used to give perceived feedback for certain interactions with the dictionary. For example, when a student selects a term, they could feel a vibration that would provide them with a more immersive and engaging experience.

Proxemic Interaction: Proxemic Interaction could be used to provide more information and context based on how close a user is to certain objects or devices.

Digital Technology to Enhance the Experience of Museum Exhibits:

Design Idea:

'**Historical Reenactments and Artifact Timeline**', an AR application that can be used to create historical reenactments, allowing visitors to step back in time and experience historical events more realistically.

Features:

- An interactive timeline that allows users to explore the historical events of an artifact chronologically. The timeline can be filtered by location, and other parameters and includes information about each event and links to related artifacts.

Application of Novel Technologies to this Design:

Tangible User Interfaces: Allow visitors to physically interact with virtual objects in AR.

Ubiquitous Computing: Provides a seamless and continuous user experience across multiple devices and locations.

Augmented Reality: Enables users to view and interact with historical reenactments and artifacts in a real-world context.

Haptic Interaction: Provides tactile feedback to enhance the visitor's sense of immersion and realism.

Proxemic Interaction: Allows for interaction with virtual objects based on physical proximity, making the visitor's experience more intuitive and natural.

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