Interaction Design with Direct Manipulation

Lecture #5

Part-C

Agenda

- Overview
- Scope
- **Applications**

Direct Manipulation Applications

- Graphical User Interface
- Embodied User Interface
- Virtual Reality
- Web Page Design
- Mobile Communication
-
- many more…….

Graphical User Interface (GUI)

- Standard elements in GUI based direct manipulation
  - Bitmapped screen
  - Desktop metaphor
  - WIMP
    - Windows
    - Icon
    - Menus
    - Pointers

Graphical User Interface (GUI)

- Standard elements in GUI based direct manipulation
  - Bitmapped screen
  - Desktop metaphor
  - **W**IMP
    - Windows
      - » Multiple windows
      - » Tiled vs. overlapping
      - » Reduce and restore
      - » Move
      - » Resize
      - » Scroll contents

Graphical User Interface (GUI)

- Standard elements in GUI based direct manipulation
  - Bitmapped screen
  - Desktop metaphor
  - W**I**MP
    - Icon
      - » Selection and activation
      - » Move into and out of fashion
      - » Static icon
      - » Animated icon
      - » Multimedia icon

Reference: Bringing Icons to Life by Baecker, Small, and Mander in SIGCHI Conference on HCI, 1991

Graphical User Interface (GUI)

- Standard elements in GUI based direct manipulation
    - Bitmapped screen
    - Desktop metaphor
    - WI**M**P
        - Menus
            - » Pull-down (from bar or top)
            - » Pop-up/contextual (from item)

Graphical User Interface (GUI)

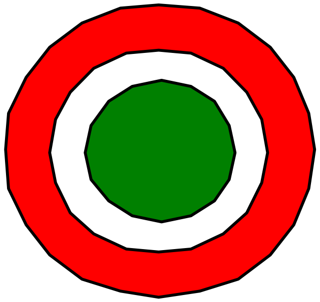
- Standard elements in GUI based direct manipulation
    - Bitmapped screen
    - Desktop metaphor
    - WIM**P**
        - Pointers
            - » Property sheets/dialogue boxes
            - » Check box
            - » Selection / radio buttons
            - » Fill-in blanks
        - Pallets
            - » Tool bars
            - » etc.

Graphical User Interface (GUI)

- Standard elements in GUI based direct manipulation
  - Bitmapped screen
  - Desktop metaphor
  - WIMP
  - **WYSIWYG**
    - Multiple selection scopes
      - » Characters, words, lines, spaces etc.
    - Move, copy, delete, insert etc.
    - Styles (font, size, face)
      - » Visible on screen
    - Automatic layout/pagination etc.
    - etc…

In Other Applications

- Direct manipulation is not necessarily with GUI
- Other elements in direct manipulation based user interface are:
  - Sensors
    - Touch screen
    - Haptic sense, pressure, temperature, force etc.
  - Spatial inputs
    - 3D interaction
      - Camera based, magnetic trackers etc.
  - Multi-modal inputs
    - Eye clicking
    - Facial movement
    - Gesture
    - Multimedia (video, audio, hand-written text) etc.



Embodied User Interface (EUI)

- This is an example of designing user interface beyond GUI
- In GUI, the virtual world inside the computer is portrayed graphically on the display
- In EUI, the computation is embodied in physical devices that exist as elements in the physical worlds
- EUI is applicable, particularly in portable computational appliances like PDA, palm series of handheld devices etc.

EUI Design

- **Design natural manipulation**
  - Hardware robustly sense and interpret manipulations
- **Treat the body of the device as part of the user interface**
  - Squeeze, shake, flick, tilt etc, may be the lexical elements in the interface
- An example: **xBook**
  - It is more than an eBook
  - It is just like a book but not made of papers rather is digital
  - It looks similar to the paper book (size, weight, usefulness) but contains more usability

xBook Design

- **Features in xBook**
  - The xBook is portable and graspable
    - They must be held, touched and carried to be used
  - This is designed to best support a limited set of specific tasks related to book reader
  - The work material are contained inside the devices
  - The devices embody the tasks they are designed for
  - The xBook casing are physically designed to make these tasks easy and natural to do.

xBook Design

- **Support from the xBook**
  - Natural manipulation
    - Tightly integrating the physical body of the device with the virtual content inside and the graphical display of the content
    - By treating the body of the xBook as part of the user interface
    - User scrolls through a menu by tilting the display
    - Zooms text by pushing/releasing/stirring

xBook Design: Requirement

- **ASIC**
  – To realize the digital devices to compute, store and controlled by the user
- **Page-sized screen with XGA resolution**
  – High-quality display so that two pages color display is okay
- **Pen input**
  – To mimic the pen, with which user would be able to mark, underlined, annotated etc. within the book
- **Voice-output**
  – Stored content can be voiced (to relief from reading the paper line by line)

Tasks: Design, Implementation and Evaluation

- We have to identify tasks
  - Turning pages
  - Annotating a document
  - Searching
  - Navigating
  - Index
  - etc.

Tasks: Design, Implementation and Evaluation

- We have to identify interface design
  - Turning pages
    - Allow user to navigate through multi-paged documents by simply turning pages
    - Allow the user to change the display pages on the devices in a manner to paper book
    - Physical manipulation in the user interface should be compatible with the physical effect of that manipulation in the analog task
      - User turns the next page with a left-to-right flick on the upper right corner of a page and turn to the previous page with a left-to-right flick on the upper-left corner

Tasks: Design, Implementation and Evaluation

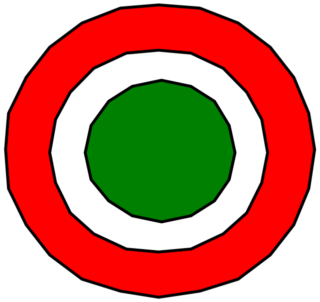
- Implementation
  - Turning pages
    - Hardware to support these flick manipulations detects finger pressure in the upper-left and upper-right corners, say
    - Put pressure sensors on the frame of the devices
    - Icon on the display area with touch sensitive

Tasks: Design, Implementation and Evaluation

- Evaluation
  - The design should be thoroughly evaluated with varieties of user in several context and change can be made accordingly

xBook Design: Other Tasks

Left as an EXERCISE!



Virtual Reality Systems

Agenda

- Introduction to VR systems
- Varieties of VR systems
- Summary of design choice

What is Virtual Reality?

- Virtual environment and virtual reality are synonymous
- Very hard to pin down in a precise definition
- Usually refers to the state where the level of interaction, autonomy and feeling of presence **is indistinguishable from the real world**

Interaction Styles in VR

- In all VR systems, following three factors are common in interaction styles
  - Sense of direct physical presence
  - Sensory cues in three dimensions
  - Natural interaction

Interaction Styles in VR

- **Sense of direct physical presence**
  - Compelling sensory cues are created by the technology to give the user a strong subjective sense of physical presence and direct experience
  - These cues may be
    - visual
    - aural
    - haptic (sense of touch, force on the body or both)
    - combination of two or more

Interaction Styles in VR

- **Sensory cues in three dimensions**
  - Whether the system exploits sense of sight, sound or touch, information in at least one of these channels is usually presented in three dimensions
- **Natural interaction**
  - Typically, VR systems allow computer-generated objects to be manipulated using gestures similar to those that one would use to manipulate real objects: picking up, turning around and so on.

What does VR offer?

- Mimicking the real world (with cost-effective solutions)
- VR has the capacity to take a user into abstract or otherwise impossible environments
- The virtual world can be microscopic or macroscopic

Application Areas Include:

- Scientific visualization and interaction
- Training (simulation)
- Engineering design and manufacturing (rapid prototyping)
- Medical (training + visual cadavers)
- Aerospace
- Architectural planning
- Operations in hazardous environment

An Example: Flight Simulator

A VR system to create most realistic experience for fighter/pilot

- **Cockpit →** displays and controls are taken from the same production line that create the real ones
- **Windows →** are replaced by high-resolution computer displays
- **Sounds →** are choreographed to give the impression of engine start or reverse thrust
- **Hydraulic jacks and intricate suspension system →** to give feelings of vibration, tilting during climbing or turning

An Example: Flight Simulator

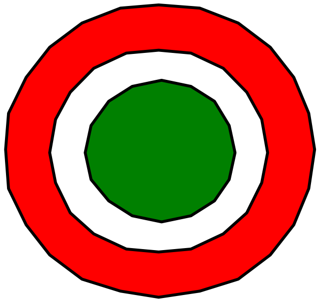
A VR system to create most realistic experience for fighter/pilot

- **Cost**
  - The elaborate technology may cost around $100 million
  - It is cheaper than the real $400 million jet
- **Benefits**
  - It is safer
  - More useful for training
  - Not complex at all
  - No specialized skill; common man can use

Cost of VR Systems

- Depends on the applications
  - Video game players $30 only

- High-performance VR systems are expensive because of the computational resources and high-resolution peripherals required to interface the human into the virtual environment



Type of VR Systems

Presently VR market has two brands

- Immersion VR systems
- Desktop VR systems

Another variation of VR is emerging

- Augmented reality

Immersion VR Systems

- User feels subjectively immersed in the computer generated world and can interact very naturally
- **Example?**

Immersion VR Systems?

- Scientific visualization and interaction
- Training (simulation)
- Engineering design and manufacturing (rapid prototyping)
- Medical (training + visual cadavers)
- Aerospace
- Architectural planning
- Operations in hazardous environment

Immersion VR Systems

- Scientific visualization and interaction
- **Training (simulation)**
- Engineering design and manufacturing (rapid prototyping)
- **Medical (training + visual cadavers)**
- **Aerospace**
- Architectural planning
- **Operations in hazardous environment**

Goggle-and-Glove Approach

- The system tracks the user's hand and head motions, finger gestures
- In general, inputs to control the scene's movement and manipulation
- Several stereoscopic devices transform otherwise 2D image data into 3D images
- Some 3D viewers, called head-mounted displays, resembles with helmets with movie screens where the visor would be

Desktop VR Systems

- Also called Fishtank VR systems
- Typically, it uses a single, large color screen for input and output, a 3D pointing device such as 3D mouse and keyboard
- The software and controller involved make it possible
- **Example?**

Desktop VR Systems?

- Scientific visualization and interaction
- Training (simulation)
- Engineering design and manufacturing (rapid prototyping)
- Medical (training + visual cadavers)
- Aerospace
- Architectural planning
- Operations in hazardous environment

Desktop VR Systems?

- **Scientific visualization and interaction**
- Training (simulation)
- **Engineering design and manufacturing (rapid prototyping)**
- Medical (training + visual cadavers)
- Aerospace
- **Architectural planning**
- Operations in hazardous environment

Desktop VR Systems

- Virtual Reality Modeling Language (VRML)
  Walter Goralski, 1996

- Enables the creation of 3D virtual environments on web-pages

- There are number of visually appealing web sites in
  - http://www.aw.com/DTUI

Augmented Reality

- A new trend in the virtual environment
- In AR, the computation is embodied in physical devices that exist as elements in the physical world
- AR recognizes that the physical configuration of computational devices is a major determinant of their usability
- **Examples**
  - xBook

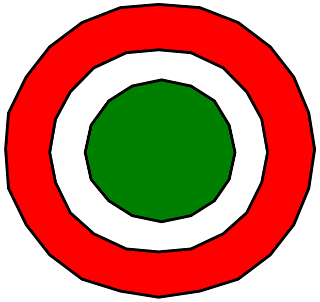
Augmented Reality: Example

- Portable computational appliances, such as handheld PDA

- A palmtop computer with a location sensor to control displays

  - As the user moves the palmtop around a location shows information about the location

  - Shopping carts with displays that advertise products as you walk down the supermarket



Designing VR Interface

- The direct manipulation principles and the OAI model is helpful to design VR systems
  - Users should be able to select actions rapidly by pointing, or gesturing, with incremental and reversible control, and display feedback should occur immediately to convey the sense of causality
  - Interface objects and actions should be simple, so that user view and manipulate task domain objects

Designing VR Interface

- Successful virtual environments will depend on smooth integration of multiple technologies:
  - Visual display
    - Display must approach real time (probably under 100 milliseconds latency) in presenting the images to the users
    - Low-resolution displays are acceptable while users or the objects are moving
    - Rapid and high-resolution display are must to preserve the sense of “being in” when there is no motion
    - Improved hardware and algorithms are needed for rapid and real-life quality displays

Designing VR Interface

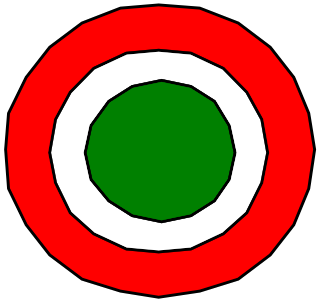
- Stereoscopic displays
  - Monoscopic – both eyes see exactly the same view
  - Stereoscopic – eyes sees separately computed views to give the sensation of stereoscopic vision
  - Moving one's head slightly makes not too distant objects move relative to each others; the closer they are, the more they move
- Head-position sensing
  - Head-mounted displays can provide differing views depending on head position
  - Devices embedded in a goggle may be used for the purpose
  - Video recognition of head position may be another choice

Designing VR Interface

- Hand-position sensing
  - Accurate measurement of hand and finger positions and rich set of gesture vocabulary is preferable
  - Hand orientation can be measured with Polhemus tracker mounted on the glove or wrist
  - Sensors for other body parts is useful
- Three-dimensional sound
  - Different sound sources with different objects
  - Good quality of 3D sound can greatly improve the feeling of subjective presence
  - 3D sounds makes tasks such as tracking moving objects, navigating and being aware of location easier, quicker and more pleasant

Designing VR Interface

- Force feedback
  - Force feedback gives users a good sense of when they grasp an object or bump into one
  - Tactile perception (senses of contact, pressure, pain, temperature etc.)
  - Small pockets all over the glove that may be pneumatically inflated under computer control to give tactile feedback
  - Small alloy pads (called tactors) can be attached to gloves, mice, joysticks and so on. When a current is passed through them, a tactor held next to the skin changes its shape and is felt to press against it. The change may be varied by controlling the current
  - Prevention of the hand passing through a computer-generated virtual object requires force feedback. A system can be employed to apply force feedback to the thumb, fingers and the palm in order to simulate the pressure exerted by virtual objects



Recommended Materials

- My Home page

  http://facweb.iitkgp.ernet.in/~dsamanta

  (For the presentation slides of the current lecture

- Book

  Designing the User Interface: Strategies for Effective Human-Computer Interaction (3rd Ed.) Ben Shneiderman, Pearson-Education, New Delhi

  Chapter 6