Human-Computer Interaction

2024/2025

Lecture 9

Input devices

universidade de aveiro
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Input Devices

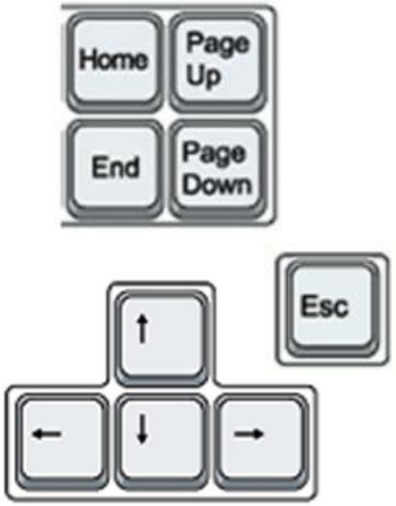
Beatriz Sousa Santos, 2025

Main Input devices

- Keyboards
- Pointing devices
  - Mouse
  - Touch screen
  - Touch pad
  - Joy stick
  - Track ball, …
- Voice recognizers
- Eye trackers
- Motion and position trackers
- 3D input devices
- …

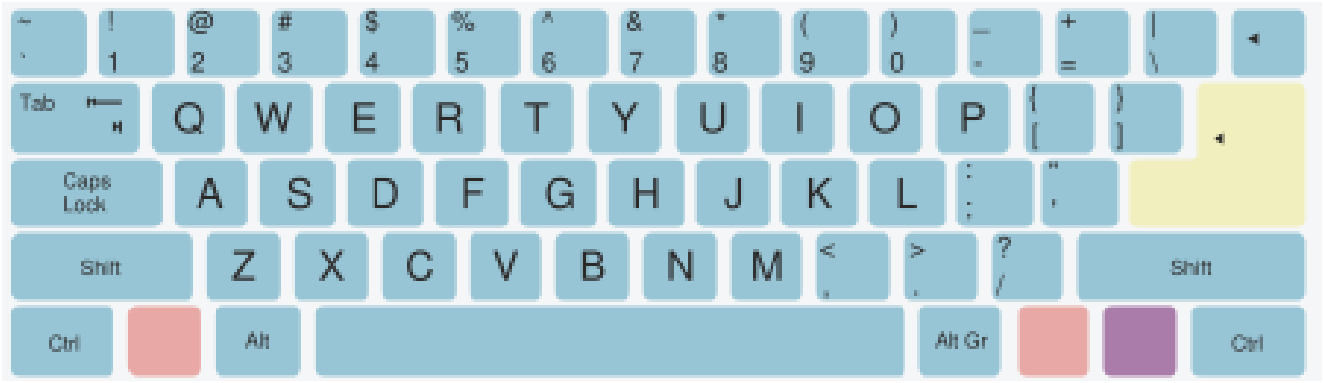
Keyboards

- Relevant issues in UI design:
  - Key layout
  - Operational characteristics:
    - Keyboard size
    - Keyboard angle
    - Hand resting area
    - Key spacing
    - Key activation force
    - Key surface and finishing
    - Key displacement
    - Activation feedback
    - Home row indicators



Keys layout

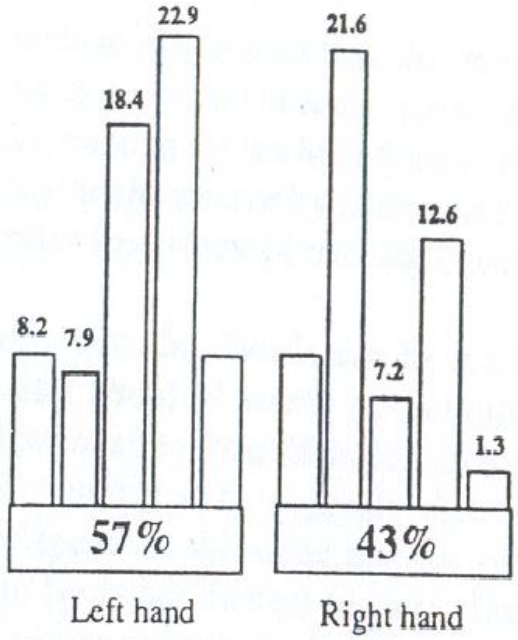
The Qwerty layout dates from the XIX century, and we still use it!

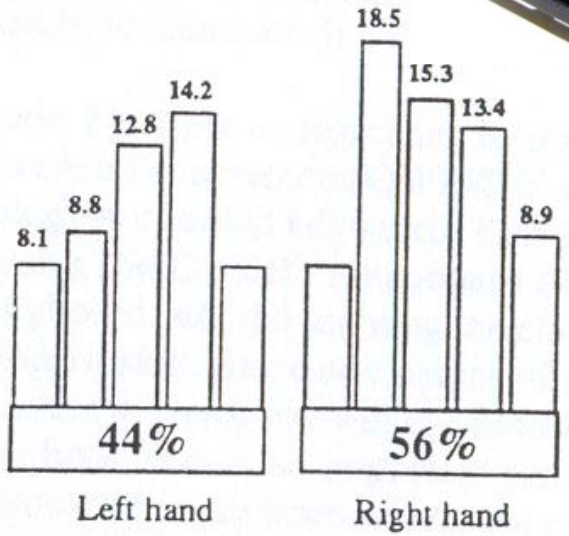


Dvorak

Combining both

Percentage of work performed by each hand (in English)



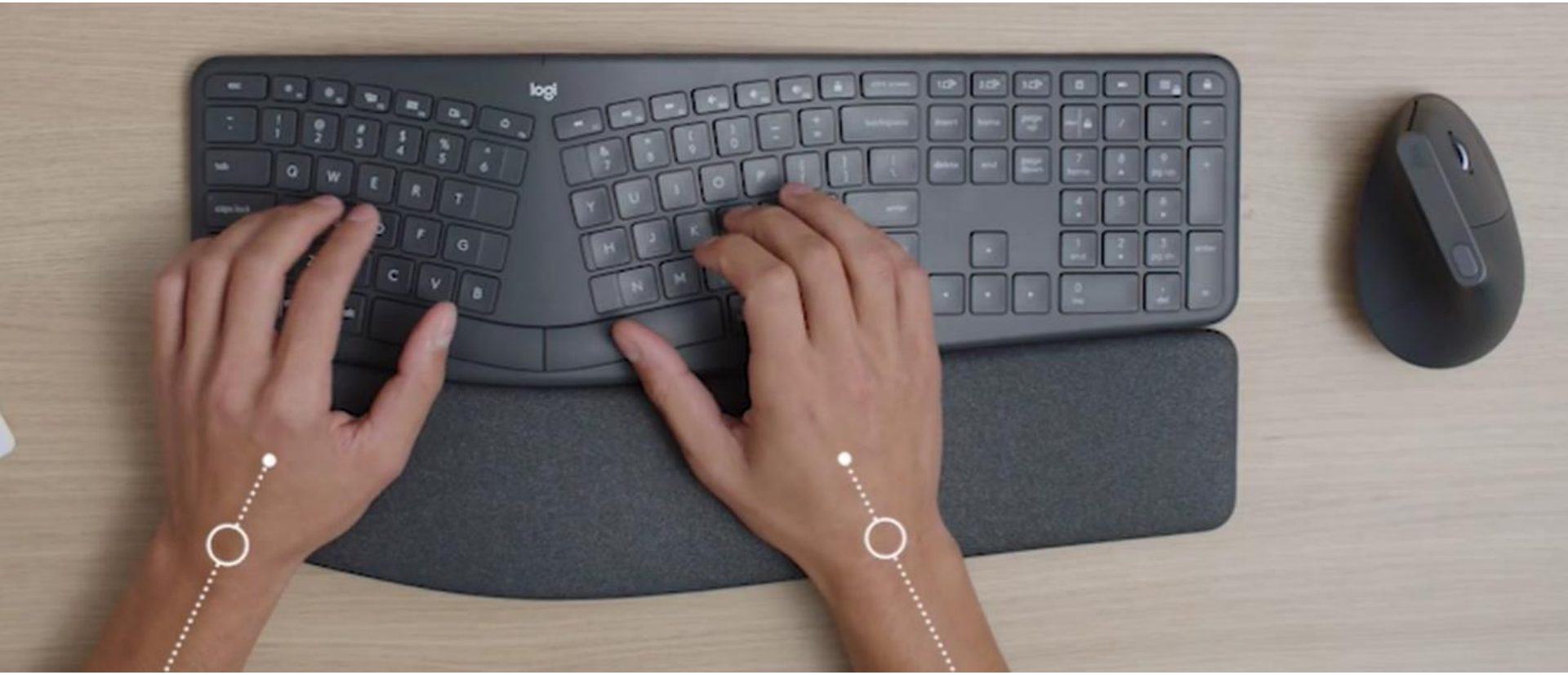


QWERTY **Dvorak**

QWERTY was devised to prevent jams in early typewriters.

The Dvorak Keyboard | Dvorak keyboard layout - Wikipedia

What is Repetitive Strain Injury (RSI)?



[Do Ergonomic Keyboards Really Help?]

Ergonomic keyboards

Help avoid RSI (Repetitive Strain Injury) WRULD (Work Related Upper Limb Disorder) and KRP (Keyboard Related Pain)

1. Zoom
2. Customizable Hot Keys
3. Improved Number Pad
4. Ergonomic Design

[Ergonomic keyboard - Wikipedia]

Keyboards for specific contexts of use

[Charachorder One review: Does this chord-centric keyboard truly work?]

Chorded keyboard used in wearable computing

[Chorded keyboard - Wikipedia]

Pointing Devices

They are used to:

- Point a target
- Select a target
- Drawing
- Positioning objects
- Orient and rotate objects
- Define paths among objects
- Handle text
- etc.

- Keyboard efficiency varies according to the tasks
- Shneiderman (98) divided them into:
  - Direct control —— touch screen
    light pen (deprecated)
  - Indirect control —— mouse
    track ball
    digitizing tablet
    joystick (track point)
    touch pad








Mice

Currently are optical

- Relative coordinates
- Different shapes, n. of buttons,…

Computer History Displays - The University of Auckland - Historydisplays - ComputerMouse

Advantages:

- Direct relation between hand and cursor movement (distance / speed / direction)
- Allow speed control
- Allow continuous movement in all directions

Disadvantages:

- Require hand movement between mouse and keyboard
- Additional space (footprint)
- Hand-eye coordination

Replica of the Engelbart's mouse

- 1963 – First Mouse. ...
- 1968 – First Trackball Mouse. ...
- Around 1980 – First Optical Mouse. ...
- 1981 – First Commercial Mouse. ...
- 1983 – First Consumer Mouse. ...
- 1984 – First Wireless Mouse
- 2004 – First Laser Mouse

Firsts: The Mouse - Doug Engelbart Institute

The Mouse - CHM Revolution

- Mice may have issues while working on glass surfaces
- Laser mice uses a laser diode instead of an LED to illuminate the surface
- The laser light is more focused and precise, allowing for higher sensitivity and smoother tracking
- Advanced models are specifically designed to overcome these challenges and perform reliably

  (Darkfield Laser Tracking with two lasers at an angle to better see the surface under the mouse)

Optical vs Laser Mouse
Logitech's MX Anywhere 3S mouse works properly on glass | The Standard

Trackballs

- Relative coordinates
- Many different shapes

Advantages:

- Direct relation between hand and cursor movement (speed and direction)
- Allow precise movements and speed control
- Allow continuous movement in all directions
- May not need additional space (footprint)

Disadvantages:

- Require hand-eye coordination
- May require hand movement between trackball and keyboard

- Uses:

- Specialized tasks: Such as CAD (Computer-Aided Design) or graphic design.

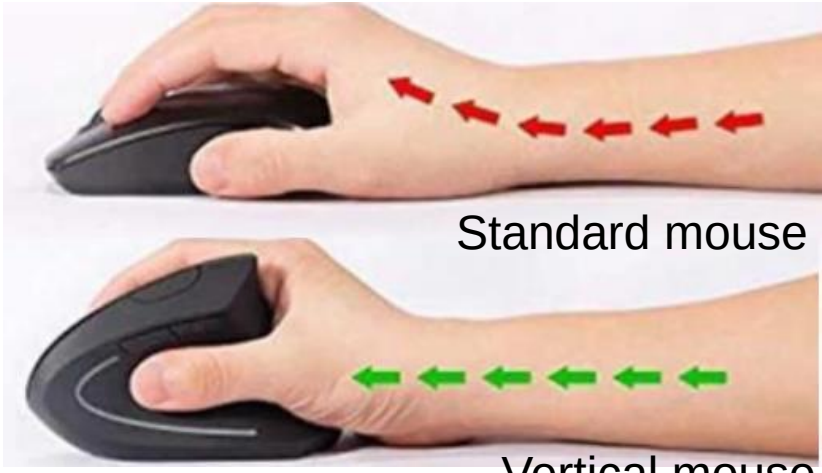
- Ergonomic solutions: For individuals who experience wrist pain or carpal tunnel syndrome

Trackball – Wikipedia
Trackball Mouse: Ergonomic Advantages and Uses | Kensington

Ergonomic Pointing Devices

Quilll mouse

Vertical mouse



Standard mouse

Vertical mouse

For users with Repetitive Strain Injury,
Carpal Tunnel Syndrome or other problems
Or to avoid these problems

Touch screens

- Usually are combined with a display
- There are several technologies

Advantages:

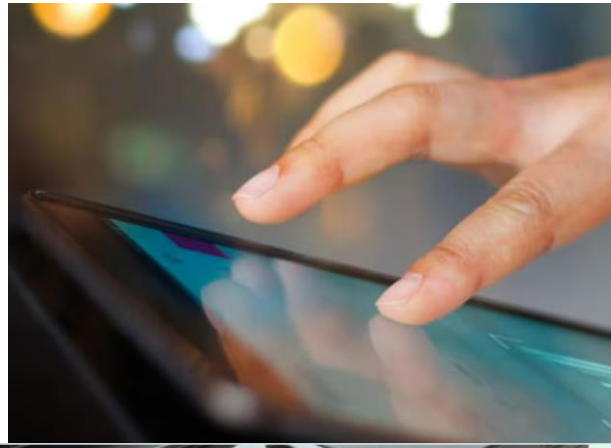
- Direct
- Do not need additional space

Disadvantages:

- May be tiring if used for long periods (“gorilla arm effect”)
- The finger may obstruct part of the screen
- …

- The concept of touch screen technology dates back to the 1960s
- Several technologies:

- Capacitive
- Resistive
- Infrared
- Surface acustic wave (SAW)



[How Do Touchscreens Work? Interactive Display Technology Explained]
[Capacitive vs Resistive Touch - Newhaven Display]
[What is a SAW touch screen and how does it work?]

- Uses:

- Mobile Devices

- Computers

- Automotive Interfaces

- Point of Sale Systems

- Medical devices

- Industrial Control Panels

- Public Information Kiosks

[Philips Touch screen module pro | Image-guided therapy systems]

Some guidelines to select touch screens

- Choose a device **after a careful task analysis and test**

- **Minimize hand and eyes movements**

- Use touch screens when
  - There is no training
  - Targets are large, discrete and scattered
  - Space is important
  - No (or little) text entry
  - Are not used for a long time

A critical situation: automotive dashboards are they improving?

[Automobile Dashboard Technology Is Simply Awful | Scientific American]

- Issues of touch screens in cars

(particularly for some controls as lights, horn, …)

[Why some people hate touch screens in cars]

[Physical buttons outperform touchscreens in new cars - ETSC]

- Other solutions may be used in future:

e.g. 3D touch screens that have raised surface in places that function as buttons

Input devices for other use cases

[Voice Recognition and the Electronic Health Record | Speech Blog]
[XR technology in medical AR VR systems]
[Frontiers | A Review on Virtual Reality Skill Training Applications]

Other Input devices...

- cameras
- eye trackers
- trackers and sensors
- microphones
- controllers of different types
- custom made devices
- etc.

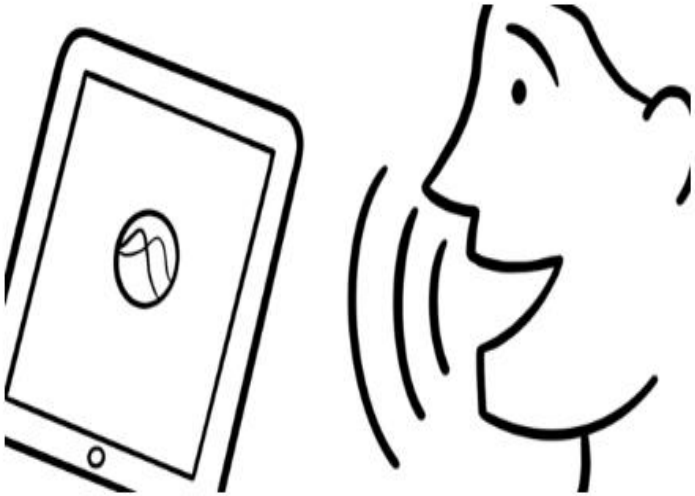
Input/output device

[Tobii Pro Glasses 3 | Latest in wearable eye tracking - Tobii]

[VR Training & Simulation Gloves for Industry & XR | MANUS]

Speech/voice recognition systems

- The first system was developed in 1972 at Bell Lab
- It is becoming more used
- Has two types of challenges:
  - Technological (have improved a lot …)
  - Human factors



Speech recognition – Technological constraints

Has evolved a lot but there are still limitations:

- Difficulty in accurately interpreting various accents, dialects, and speech impediments
- Operation in noisy environments
- Privacy and security

…

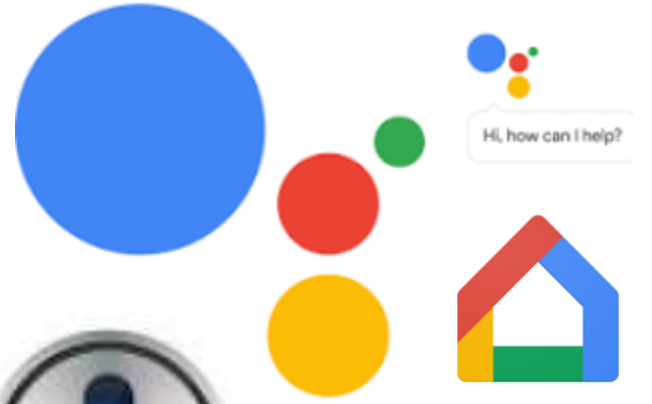
Speech recognition as input

Independently of the technology state of the art,

- Has advantages when the user:
  - Has physical deficiency
  - Must move around
  - Has eyes busy
  - Is in a low visibility or cluttered environment

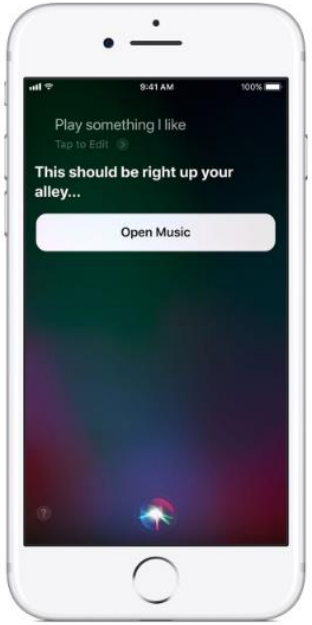
- Has inherent disadvantages:
  - Voice is transient
  - Does not have natural feedback
  - May disturb other people
  - May result in lack of privacy
  - May be slower and more tiresome (overloading STM)

- Consider voice input when:
  - The user has to move
  - Has eyes or hands busy



- Avoid voice input when:
  - Privacy is important
  - Error taxes, even low, are not acceptable
  - Usage frequency is high
  - Speed is important

- Voice input/output has became more used



Some guidelines for voice interfaces

- Provide output dialog with structure to guide input
- Use a distinct and familiar vocabulary to avoid errors
- Consider voice input if technology constraints are acceptable considering:
  - Ambient noise
  - Privacy
  - Vocabulary extent
  - Error cost

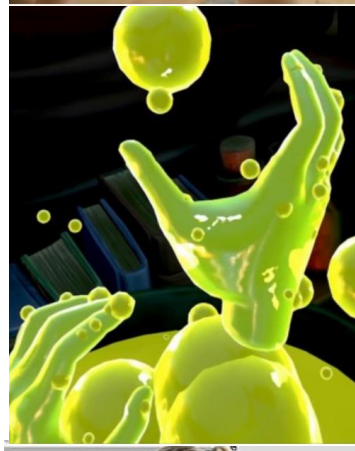
“No matter how different the technology, **the people who are using it haven’t changed**. And most usability principles have more to do with human capabilities and limitations than with technology. (Examples of such eternal design principles include error prevention, flexibility, efficiency, visibility of system status, and recognition vs. recall.)”

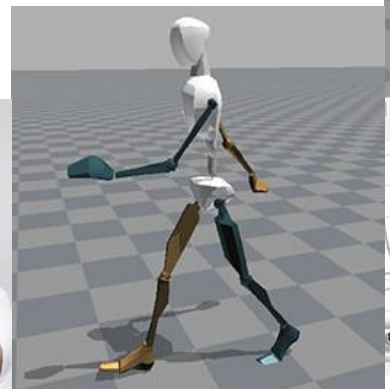
Voice Interaction UX: Brave New World...Same Old Story

How to Design Voice User Interfaces | IxDF

Input devices for 3D user interfaces
(mostly used in Virtual Reality)

- Trackers:
  - Magnetic
  - Optical
  - Inertial, ...
- Navigation and manipulation interfaces:
  - Controllers, ...
- Gesture interfaces:
  - Gloves
  - Spatial gestures sensors, …




Navigation, manipulation, drawing, …
Input Devices

- Controllers
- pens
- …

more or less sophisticated and expensive

- Perform relative position/velocity control of virtual objects

MR Stylus for Meta Quest 3, Meta Quest 2 | Logitech

Gesture Input Devices

TactGlove consumer-ready haptic gloves for VR

- May be cameras or gloves

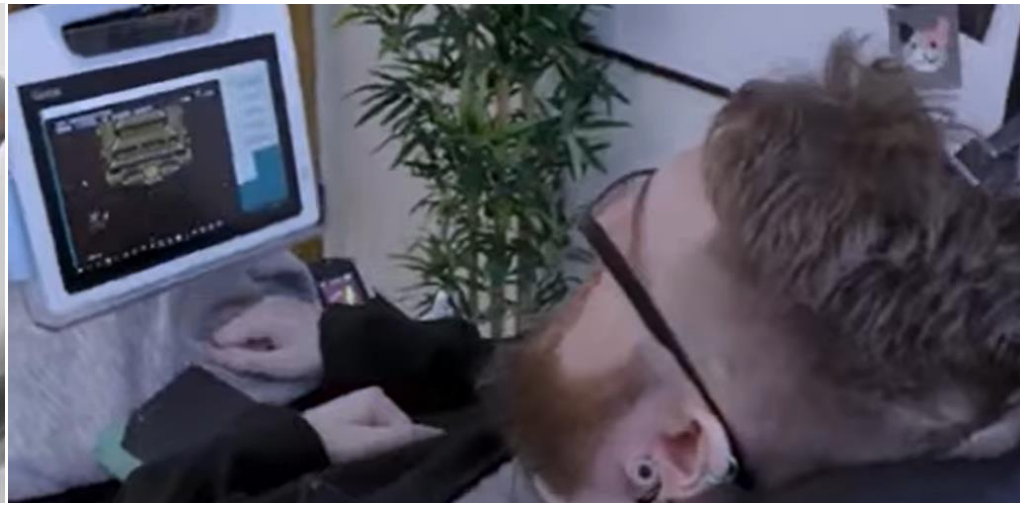
- There are/ have been various sensing gloves such as:
  - Fakespace Pinch Glove (switches)
  - Immersion CyberGlove (stain gauges),
  - Avatar VR

Nova Haptic Glove
SenseGlove

- Most need some calibration for user's hand
- Gloves usually are also (haptic) output devices

CyberTouch

Brain-Computer Interfaces
(are evolving …)



[Top 7 Brain Computer Interface (BCI) Devices]

[Brain-Computer Interfaces: Exploring the Last Frontier]

When choosing an input device, consider:

- Ergonomics / human factors
- Typical scenarios of use
- Cost
- Generality
- DOFs (Degrees Of Freedom)
- Output devices
- Interaction techniques
- …

Never use a technology because it is “cool”!

What future?

It seems likely that we will use more often:

- 3D input
- gestures
- voice input
- two hand input
- tactile/force feedback
- wearable devices
- whole-body environments
- brain-computer interfaces …