Devices

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Outline

Introduction

Keyboards and keypads

Pointing devices

Displays

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Input and output devices represent the physical medium through which users operate computers

Only two decades ago, the standard computer platform was the desktop or laptop personal computer equipped with a screen, a mouse, and a keyboard

Introduction

Mobile devices have revolutionized the face of computing

- Many people do not realize that their ever-present smartphones, tablets, or portable MP3 players are, indeed, powerful computers

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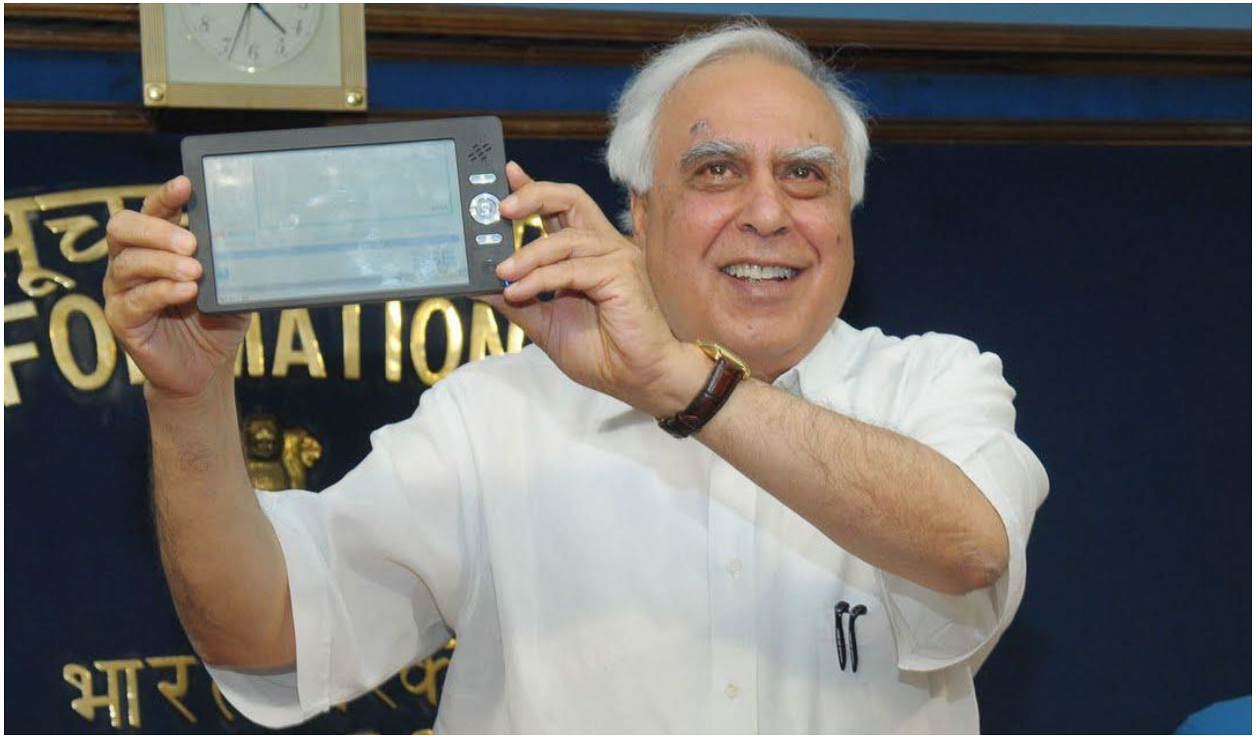
Device example

- Indian IT minister Kapil Sibal announcing the Aakash, a $35 tablet for the Indian market



Introduction

Another device example

- The Owlet wearable baby monitor that continuously tracks a baby’s heart rate and oxygen saturation using a so-called “smart sock” (left) and wirelessly sends the information to a base station (center)

Introduction

The explosion of new and exciting computing technology has increased the importance of interaction design so as to accommodate such a wide diversity of input and output modalities

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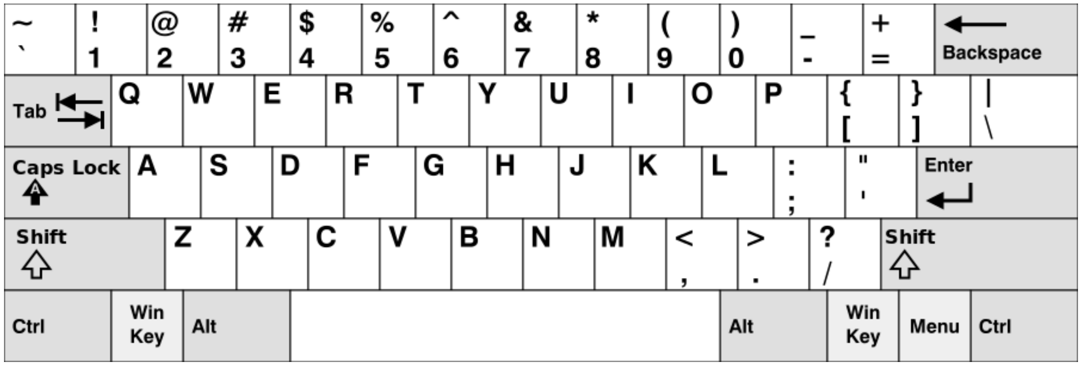
Keyboards and keypads

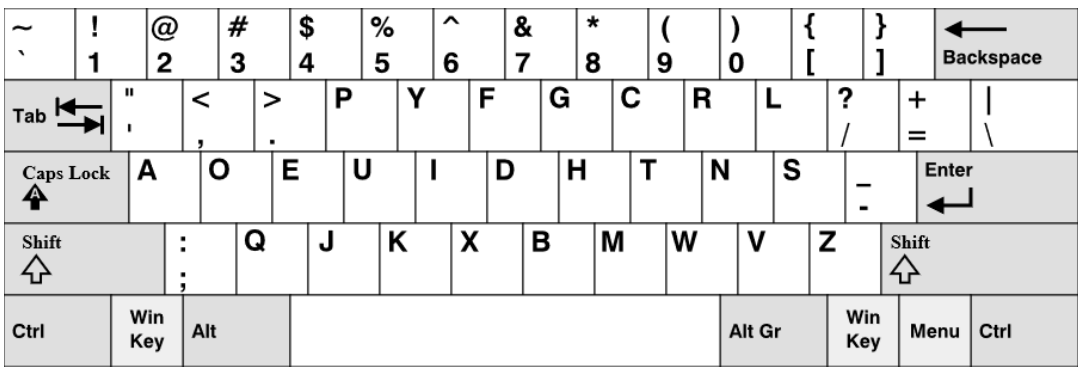
The keyboard is the primary mode of text entry

Despite having received much criticism over the years, the keyboard is very successful and still represents the most efficient text-entry mechanism

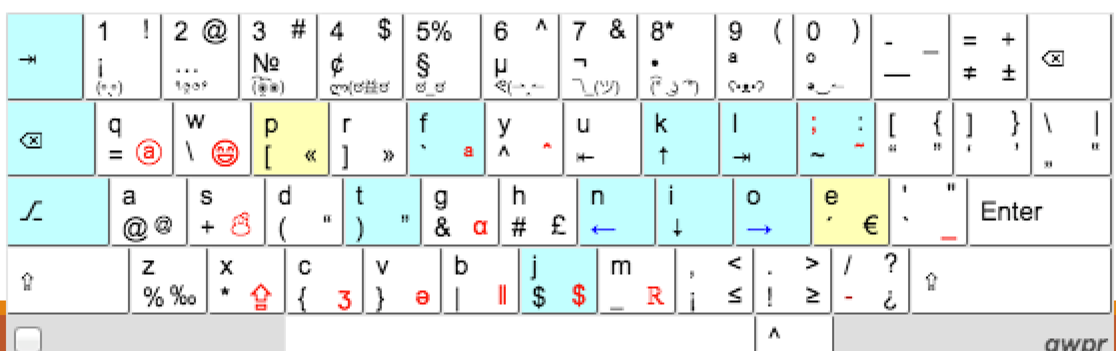
Keyboard layouts



QWERTY Keyboard



Dvorak Keyboard



QWPR Keyboard

Keyboard layouts

Number pads

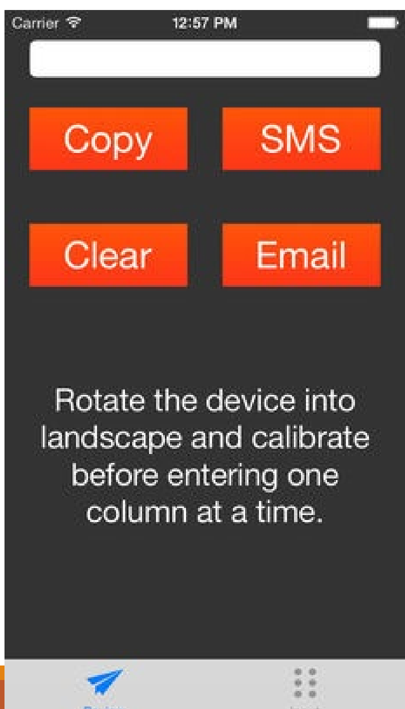
Ergonomic keyboard

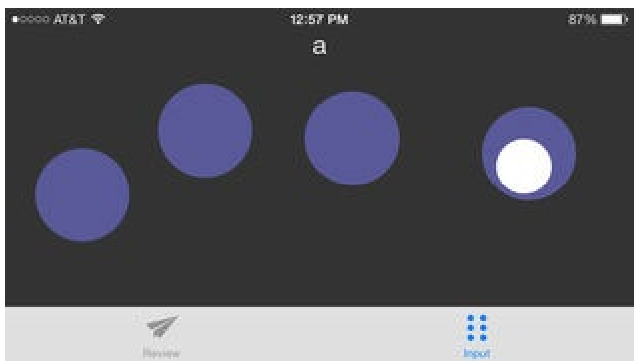
Accessible "keyboard"

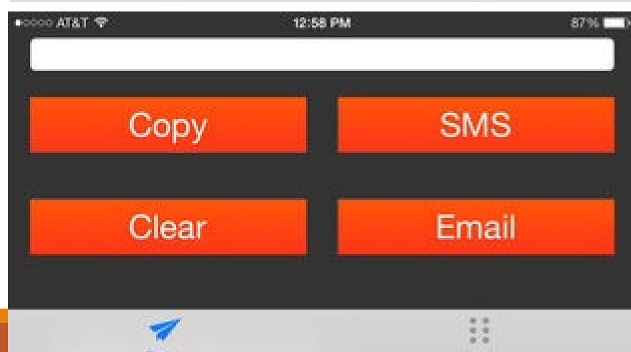
Approaches to facilitate users inputting texts include:

- Adaptive keyboards
- On-screen keyboards using head pointers or oversized trackballs

PerkInput and BreaillTouch provide nonvisual input methods







Accessible "keyboard"

orbiTouch Keyless Keyboard with integrated mouse functionality

The orbiTouch requires no finger or wrist motion to operate, yet supports high-performance typing and pointing

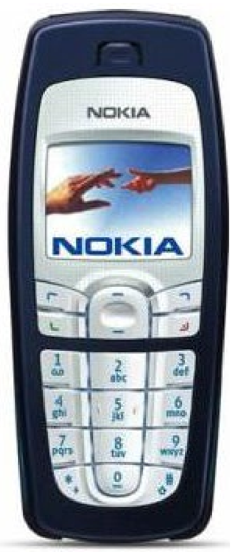
Mobile text entry

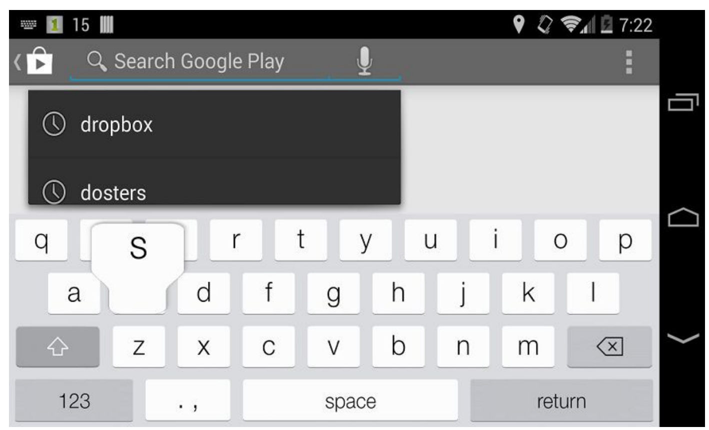
Most older mobile devices provide only a numeric keypad

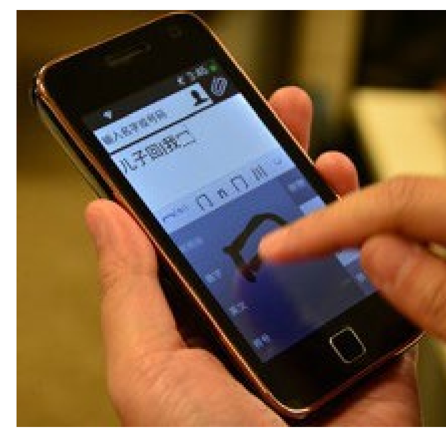
Smartphones tends to eschew physical keyboards in favor of soft keyboards

However, soft keyboards lack the tangible and tactile feedback of a physical keyboard

To improve text entry on touchscreens, possible words are predicted for users







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Pointing devices

It's convenient for the user to point at and select items

This direct-manipulation approach is attractive because the users an avoid having to learn commands, reduce the chance of typographic errors, and keep their attention on the display

Pointing devices are also important for small devices and large wall displays

Pointing tasks and control modes

Pointing devices are useful for seven types of interaction tasks:

Select – Choosing from a set of items.

Position – Choosing a point in a one-, two-, three-, or higher-dimensional space

Orient – Choose a direction in a two-, three-, or higher-dimensional space.

Path – Define a series of positioning and orientation operations

Quantify – Specify a numeric value

Gesture – Perform an action by executing a predefined motion

Text – Enter, move, and edit text in two-dimensional space

Pointing tasks and control modes

In the past, the keyboard was used for all of these purposes, but now most users employ pointing devices

Pointing devices can be grouped into

- Those that offer direct control on the screen surface
  - Touchscreen or stylus
- Those that offer indirect control away from the screen surface
  - Mouse, trackball, joystick, touchpad

Pointing devices can also be grouped by whether they absolute or relative input

- Absolute input: Touchscreens, graphics tablet, and eye-tracker
- Relative input: Mouse, joystick, trackball

Direct-control pointing devices

Touchscreens are canonical direct control pointing devices

Touchscreens are often integrated into apps directed at novice user

High-precision designs dramatically improved touchscreens

- Hardware provides up to 1600*1600 pixel resolution
- The lift-off strategy enables users to point at a single pixel

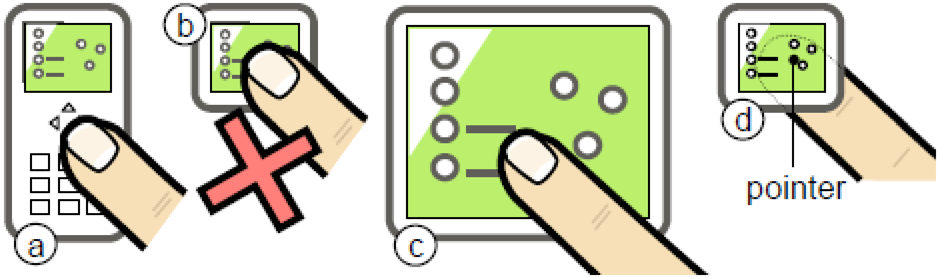

Direct-control pointing devices

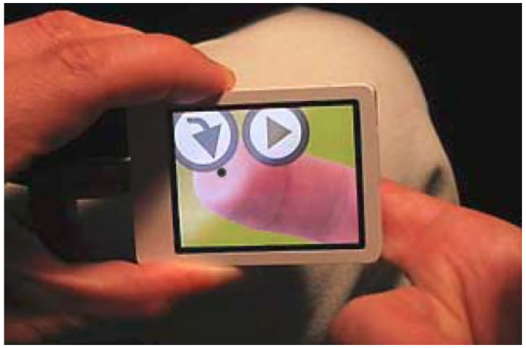
High-precision touchscreens have transformed mobile devices

- "Fat finger" problem

Solution

- Using the back of the device





- Shift

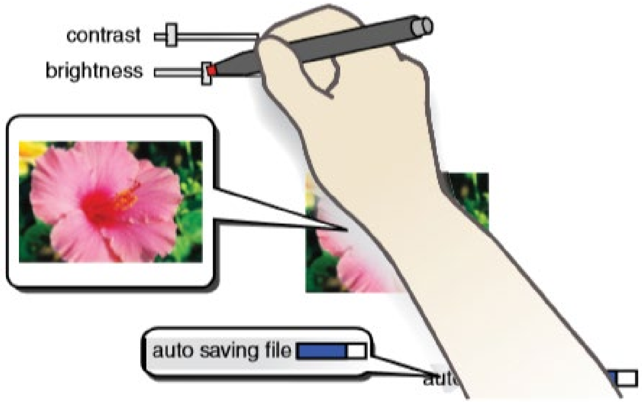
Direct-control pointing devices

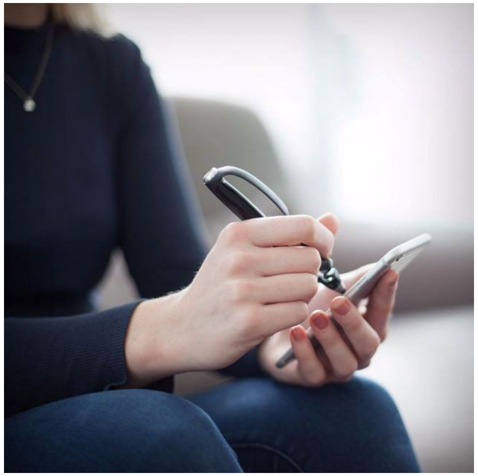
High-precision touchscreens have transformed mobile devices

- “Fat finger” problem

Solution

- Occlusion-aware interfaces
- Stylus





Indirect-control pointing devices

Indirect pointing devices separate the input (monitor) space from the output (display) space

Provide a surface for the hand to rest

However, they require the hand to locate the device and demand hand/eye coordination

Indirect-control pointing devices

The *mouse* is the most common indirect pointing device

Problems:

- Consume desk space
- Separate attention between the motor and display space



The *trackball* is controlled by spinning a ball along two axes

Indirect-control pointing devices

The joystick has dozens of versions with varying stick lengths and thicknesses, displacement forces and distances, anchoring strategies for bases, and placement relative to the keyboard and screen

Joysticks are appealing for tracking purposes

Indirect-control pointing devices

The direction pad originated in game consoles and consists of four directional arrows arranged in a cross with a trigger button in the center

Indirect-control pointing devices

The graphics tablet is a touch-sensitive surface separate from the screen, usually laid flat on the desk/table or in the user’s lap

Comparison of pointing devices

Speed

- Touchscreen <mouse < trackball/touchpad < pointing stick

For some tasks, pointing devices are faster than cursor keys, while for other tasks, they are not

Users with motor disabilities prefer joysticks and trackballs

Fitts's Law

Fitts's Law models human hand movement

$$MT = a + b * \log_2(\frac{D}{W} + 1)$$

a and b need to be determined experimentally for a device

Example:

a = 300 milliseconds

b = 200 msec/bit

D = 14 cm

W = 2cm

$$MT = 300 + 200 * \log_2\left(\frac{14}{2} + 1\right)$$

$$= 900$$

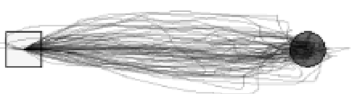
Designers can decide optimal locations and sizes of elements on the screen using Fitts's Law

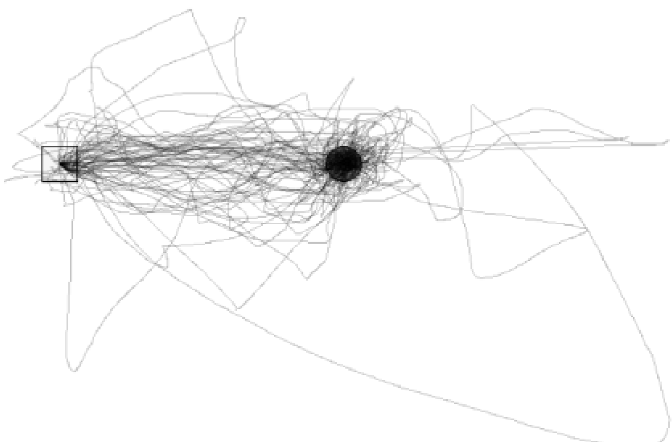
Fitts's Law

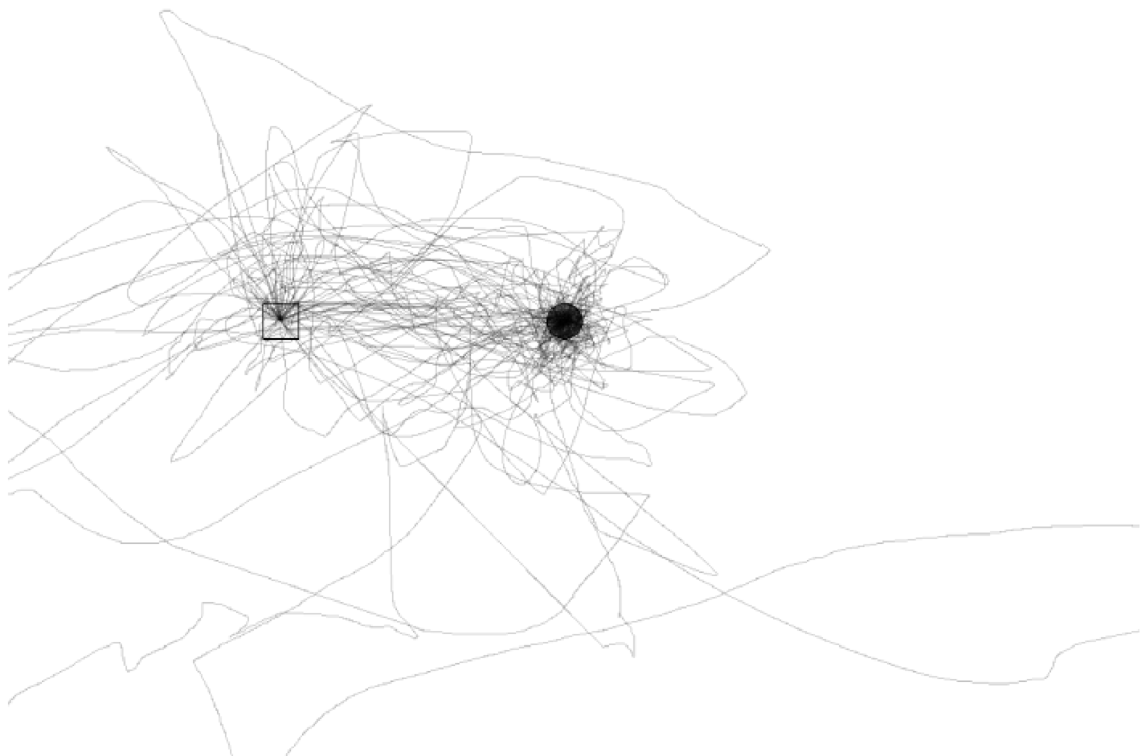
There is also a fine-tuning motion of the fingers to move in small targets

$$PPMT = a + b * \log_2(D/W + 1) + c * \log_2(D/W)$$

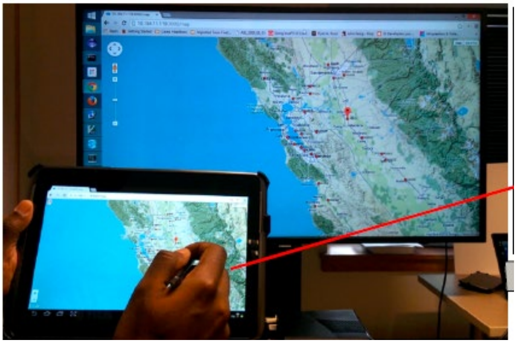
Fitts's Law works well for the adults, but it need refinements for children or older adults.







Novel pointing devices



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Characteristics of displays

Physical dimensions (usually the diagonal dimension and depth)

Resolution (the number of pixels available)

Number of available colors and color correctness

Luminance, contrast, and glare

Power consumption

Refresh rates (sufficient to allow animation and video)

Cost

Reliability

Display technology

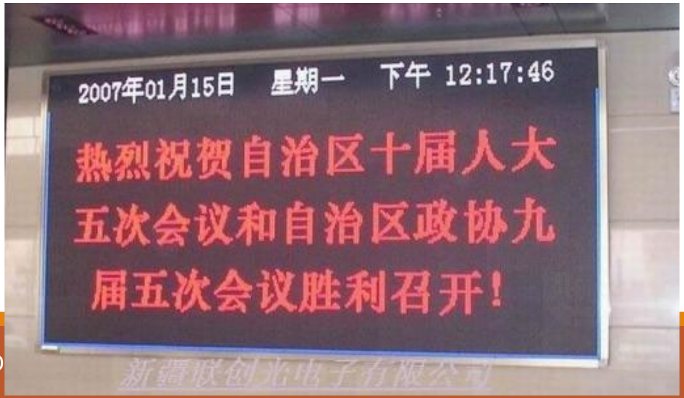
CRT -> LCD

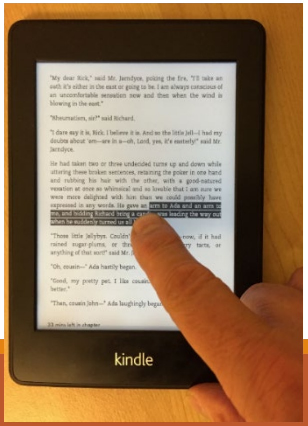
- Thin form, light weight, low electricity consumption

Plasma displays are suitable for mounted wall displays

LEDs are being used in large public displays

Electronic ink displays





Large wall displays

There are three types of large wall displays

- Informational wall displays
- Interactive wall displays
- Multiple-desktop displays

Tabletop displays

Horizontal displays invite collaboration and discussion

- Such as creative design, problem solving

Tabletops are often equipped with multi-touchscreens

Using stereoscopic displays, volumetric displays, or head-mounted displays, it may become possible to design effective 3D tabletop interactions

Heads-up and head-mounted displays

A heads-up display projects information on the partially silvered windscreen of an airplane or car

The head-mounted display (HMD) are used in VR or AR apps

Mobile device displays

Mobile devices widespread in personal and business applications

- They can improve medical care, facilitate learning, etc.

Smartwatches integrate step counters, heartbeat, GPS, text, email, calendar, voice recognition, and electronic payment

Mobile device displays

Mobile devices can be grouped in four classes depending on their intended usage

- General-purpose work (Pocket PC)
- General-purpose entertainment (iPod)
- General-purpose communication and control (phones)
- Targeted devices that do only a few tasks

When design interfaces for mobile devices, data entry and complex tasks should be reduced

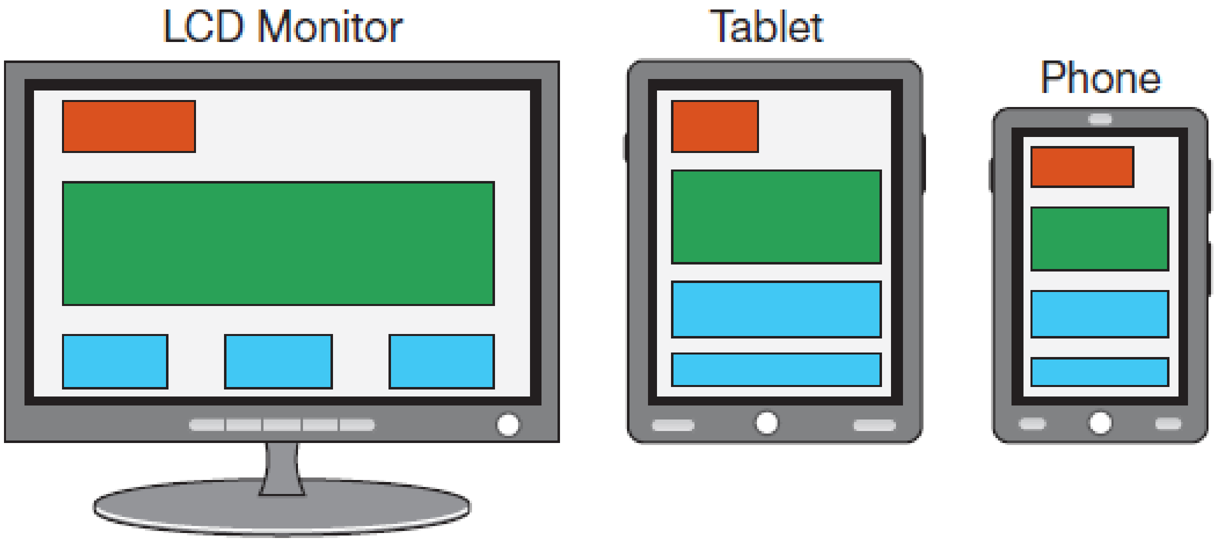
Responsive design

Interaction design for mobile devices requires adapting content to display

Responsive web design (RWD) is an approach to creating webpages and web apps

Basic principles of RWD

- Mobile-first design
- Unobtrusive dynamic behavior
- Progressive enhancement



Deformable and shape-changing display

Current displays are flat

Future displays will be shape-changing in that they bend, move, and respond to physical interactions