

# User Interface Design & Implementation

## *Interaction Devices*

Week 6 – Lecture 13

January – May Term, 2020

# Today's Topics

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- Interaction Devices
- Input Devices
- Output Devices
- Integrated Input & Output Devices

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- **Interaction Devices**
- Input Devices
- Output Devices
- Integrated Input & Output Devices

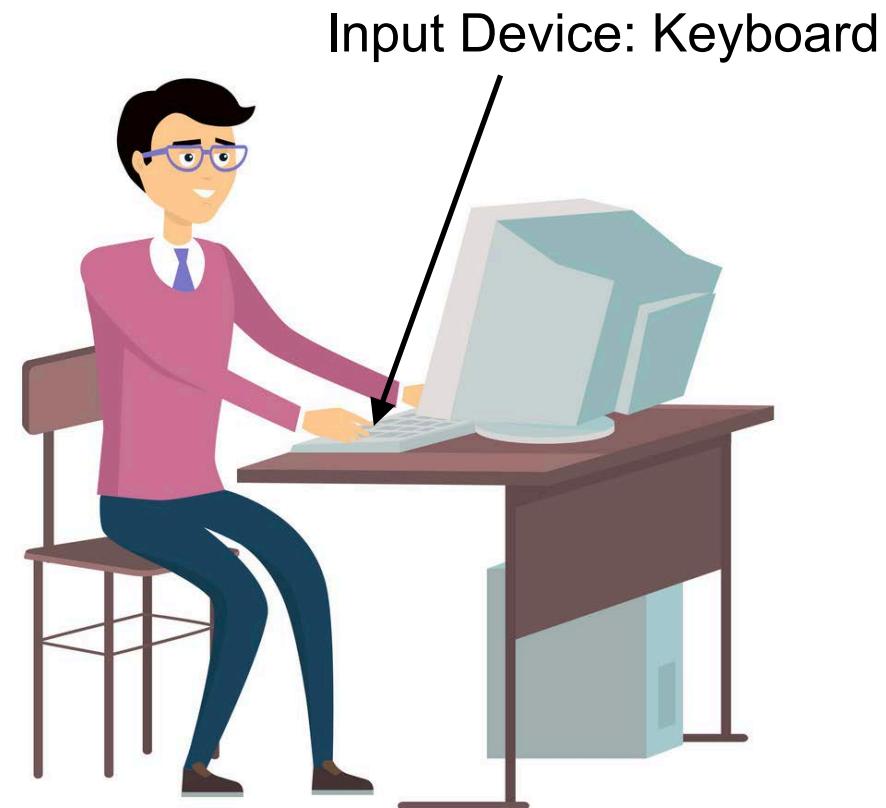
# Interaction Devices

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- Interaction devices are **hardware** elements
  - connect the physical human effectors (e.g., hands) to the input channels of computers
  - are the **channels** through which users and software communicate
- Interaction devices can be classified into
  - **Input devices**: users provide inputs to computers
  - **Output devices**: users receive outputs from computers

# Input Devices

- Transform input data or instructions from the user into a form that a computer can process
  - Touch
  - Sound
  - Gesture
  - Gaze
  - Brainwaves



# Output Devices

- Convert what the computer has processed into a form that we can understand

- Visual: texts, photos, icons, animations
- Sound: music, voice
- Tactile: force, torque, vibration

Output Device: Display



# Motivation

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- The devices used for input and output (I/O) determine the nature and capacity of information transferred between human and computer
- Characteristics of I/O devices influence user interface design to a large degree
- Combinations of I/O devices can increase the usability of a system
- The choice of an inappropriate or inadequate I/O devices will diminish the performance of the task

# Objectives

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- Identify the main I/O devices used in computer systems
- Know the important characteristics of these devices
- Evaluate the suitability of I/O devices for particular purposes or tasks
- Be able to select an appropriate combination of I/O devices for a specific task

# Today's Topics

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- Interaction Devices
- **Input Devices**
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# Input Devices

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- Keyboards
- Pointing devices
- Tracking devices
- Visual-input devices
- Audio-input devices

# Keyboards

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- One of the primary input devices used with a computer
- Keyboards allow users to input letters, numbers, and other symbols into a computer
- Uses an arrangement of buttons or keys
- Requires pressing and holding several keys simultaneously or in sequence



# Keyboard Types



Standard keyboard



Gaming keyboard



Laptop keyboard



Foldable keyboard



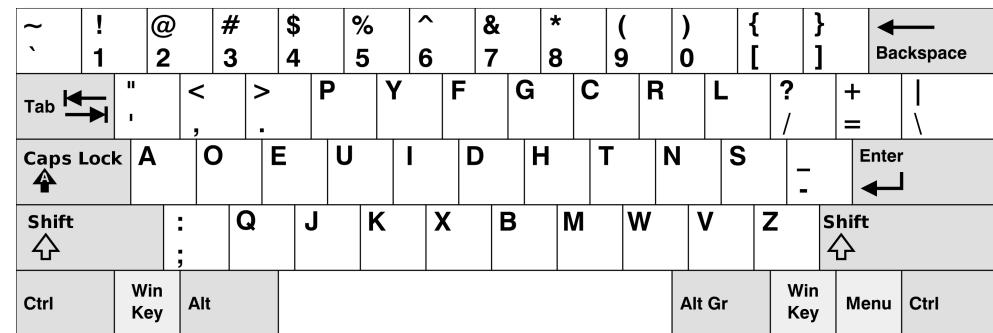
Thumb-sized keyboard



Projection keyboard

# Keyboard Layouts

- QWERTY (1870s)
  - most common layout
  - fewer typewriter jams
- DVOARK (1920s)
  - emphasis on reducing errors, high typing speed, and typist comfort
  - but it fails to gain acceptance
- ABCDE
  - easier for non-typists
  - studies show no improvement vs. QWERTY



# Point Devices

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- A **pointing device** is a hardware input device that allows the user to move the mouse pointer to select items on a display screen
- Six typical interaction tasks of pointing devices
  - **Select**: choose from a set of items
  - **Position**: choose a point in a one-, two-, three-, or higher-dimensional space
  - **Orient**: choose a direction in a two-, three-, or higher-dimensional space
  - **Path**: rapidly perform a series of position and orient operations
  - **Quantify**: specify a numeric value
  - **Text**: indicate the location of an insertion, deletion, or change of text

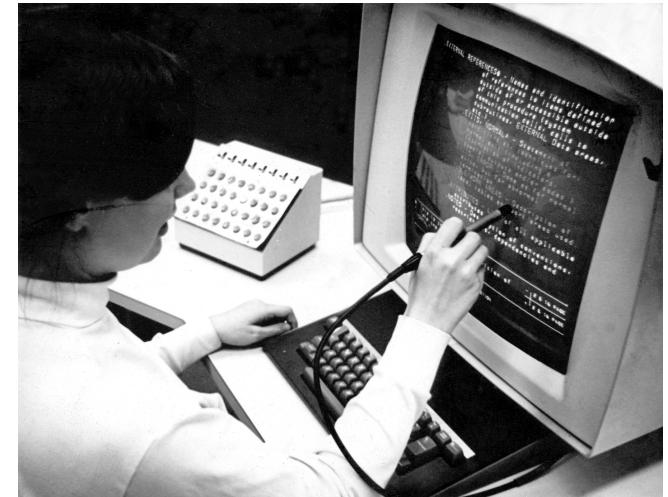
# Pointing Devices: Two Types

- **Direct-control** Pointing Devices: Interaction is performed directly **on the display screen surface**
  - Pros: save physical space; easy for novice users
  - Cons: obscuration issue; hand-fatigue issue
- **Indirect-control** Pointing Devices: Interaction is performed away from the display screen surface, and motions are mapped to the display
  - Pros: Reduce obscuration and hand-fatigue problems
  - Cons: cognitive load; require enough physical space



# Direct-control Pointing

- First pointing device – **Light pen**
  - Point to a place on screen and press a button
  - *Pros:* easy to understand and use; very fast for some operations (e.g. drawing)
  - *Cons:* hand gets tired fast; hand and pen block view of screen; fragile



[Light pen](#)

- Evolved into the **Touch screen**
  - *Pros:* very robust, no moving parts
  - *Cons:* accuracy could be an issue



# Indirect-Control Pointing

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- Mouse
  - Pros: familiarity, wide availability, low cost, easy to use, accurate
  - Cons: desk space, encumbrance (wire), long motions are not obvious
- Trackball
  - Rotate the ball to move the pointer
  - Small physical footprint
- Joystick
  - A stick pivots on a base and reports its angle
  - Easy to use, lots of buttons



# Indirect-Control Pointing

- Pointing stick
  - Pressure-sensitive ‘nubbin’ on laptops
  - Keep fingers on the home position
- Touchpad
  - Move a finger on the pad to move the pointer
  - Laptop mouse device
- Graphics Tablet
  - Move stylus on a touch-sensitive drawing surface
  - Good for CAD, artists



# Tracking Devices

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- Motion tracking
- Eye tracking

# Motion Tracking

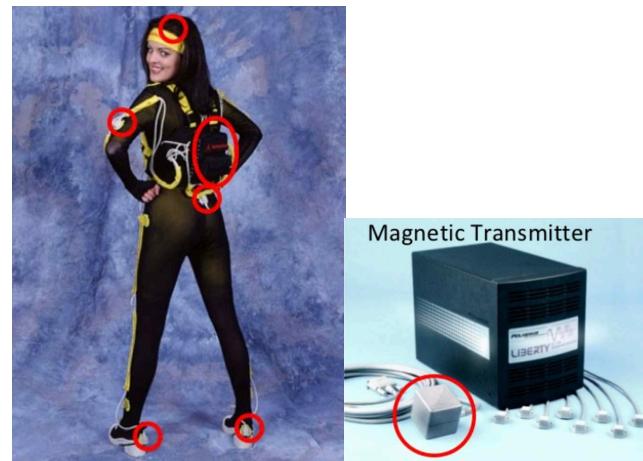
- We want to use the human body as an input device
  - *interaction input*: **position/orientation** of hands, body, and head
  - *advantages*: more natural; lead to higher level of immersion



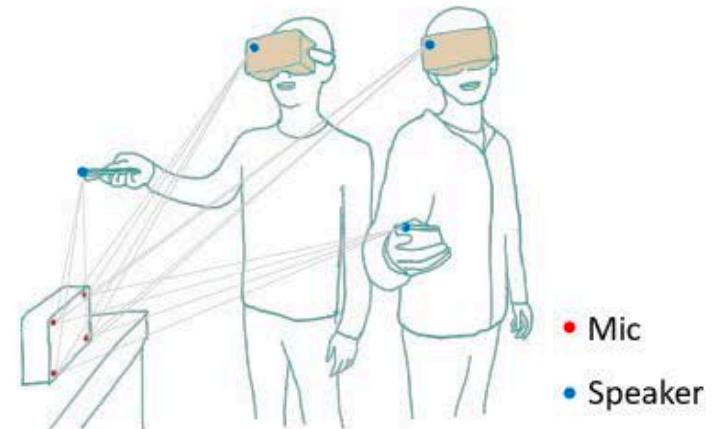
# Motion Tracking Techniques



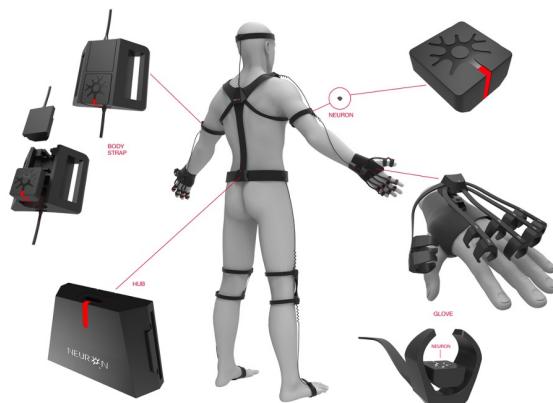
**Mechanical** tracking



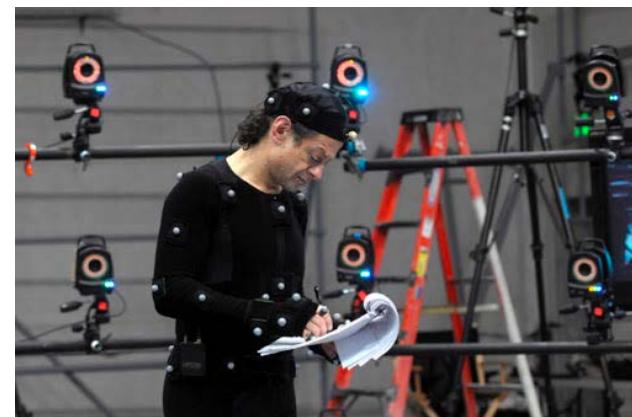
**Magnetic** tracking



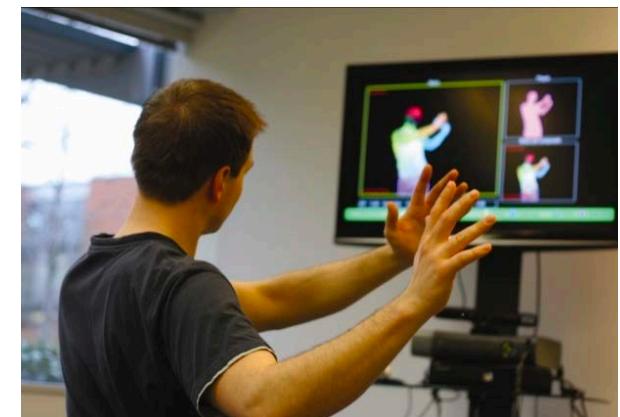
**Acoustic** tracking



**Inertial** tracking



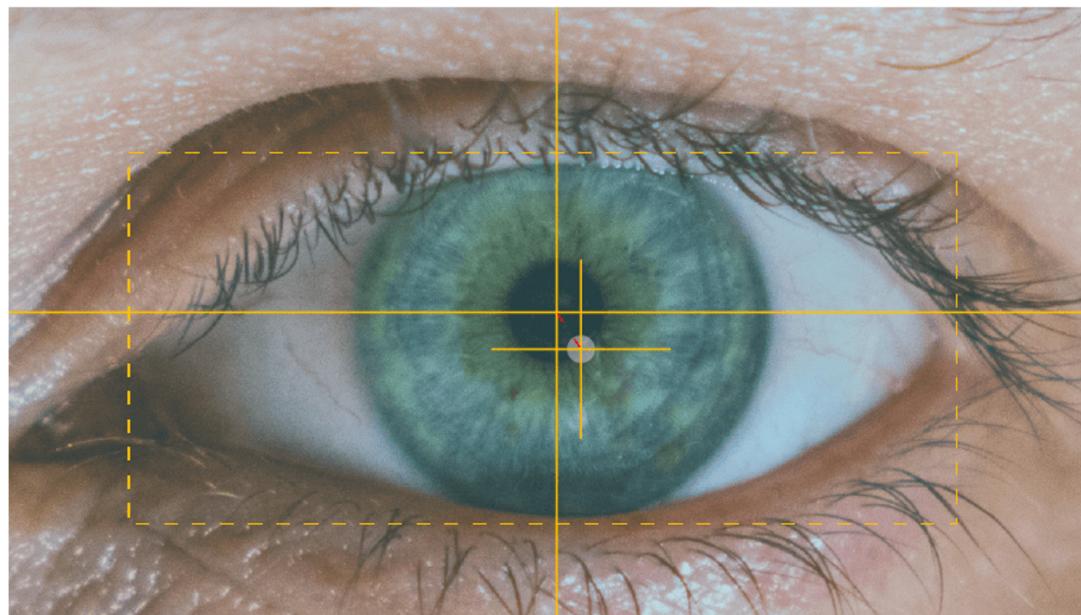
**Optical** tracking (markers)



**Optical** tracking (markerless)

# Eye Tracking

- Eye tracking refers to the process of measuring where we look, also known as our point of gaze.
- These measurements are carried out by an eye tracker that records the position of the eyes and the movements they make.



The center of the eye (pupil center) is tracked in relation to the position of the corneal reflection. The relative distance between the two areas allows the calculation of the direction of the gaze.

# Eye Tracking Techniques

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- Screen-based eye tracking
  - require respondents to sit in front of a monitor and interact with screen-based content
  - track the eyes only within certain limits



- Eye tracking glasses
  - allow respondents to move freely
  - glasses could potentially shift during the recording for a large movement (e.g., sports)



# Visual-input Devices

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- Data scanning devices
  - Image scanner
  - Barcode scanner
  - Optical mark recognition (OMR)
  - Magnetic ink character recognition (MICR)
  - Optical character recognition (OCR)
- Image capturing devices
  - Digital camera
  - Digital video camera

# Data Scanning Devices

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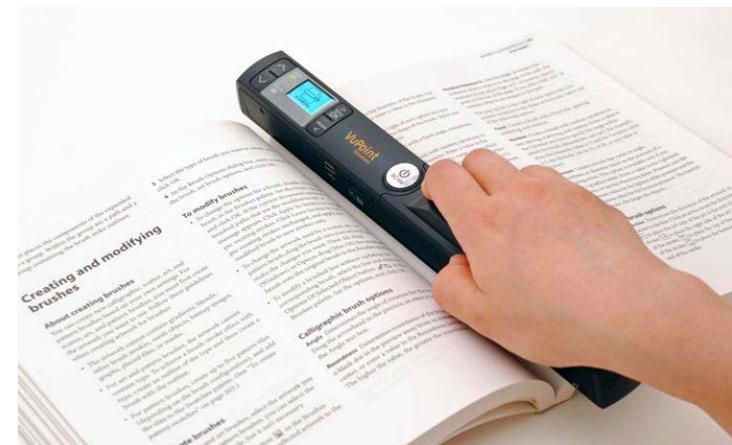
- Scanning devices enable direct data entry into a computer system from source documents
- Eliminate the need to key in text data into the computer
  - improve data accuracy
  - increase the timelines of the information processed
- Some data scanning devices are also capable of recognizing marks or characters

# Image Scanner

- Input device translates paper documents into an electronic format (e.g., image) for storage in a computer
- Stored image can be altered with an image-processing software
  - cannot do any word processing of the document
  - require more storage space than text



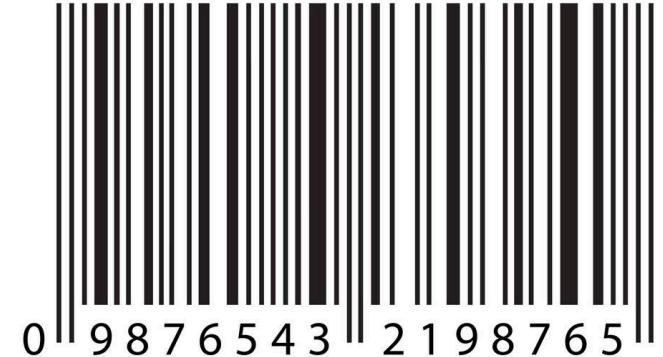
Flatbed scanner



Handheld scanner

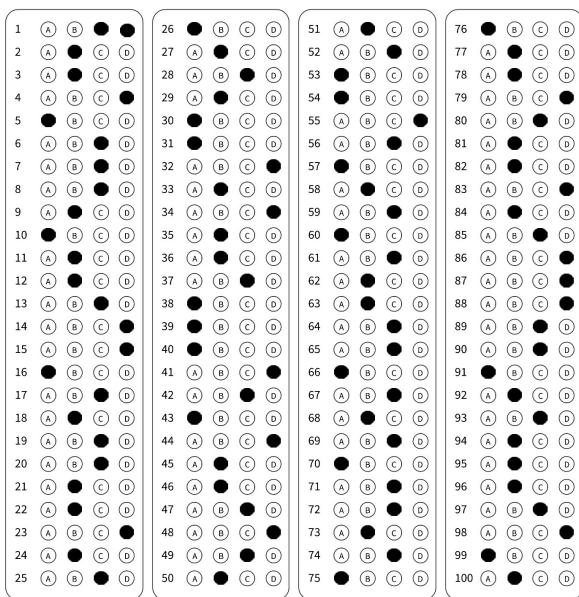
# Barcode Scanner

- Barcodes represent alphanumeric data by a combination of adjacent vertical lines (bars) by varying their width and spacing between them
- Scanner used for reading bar-coded data
  - use laser-beam to stroke across pattern of barcodes
  - different patterns of bars reflect the beam in different ways sensed by a light-sensitive detector
  - Universal Product Code (UPC) is the most widely known barcoding system



# Optical Mark Recognition (OMR)

- OMR scanner capable of recognizing a pre-specified type of mark by pencil or pen
- Very useful for grading tests with objective type questions, or for any input data that is of a choice or selection nature



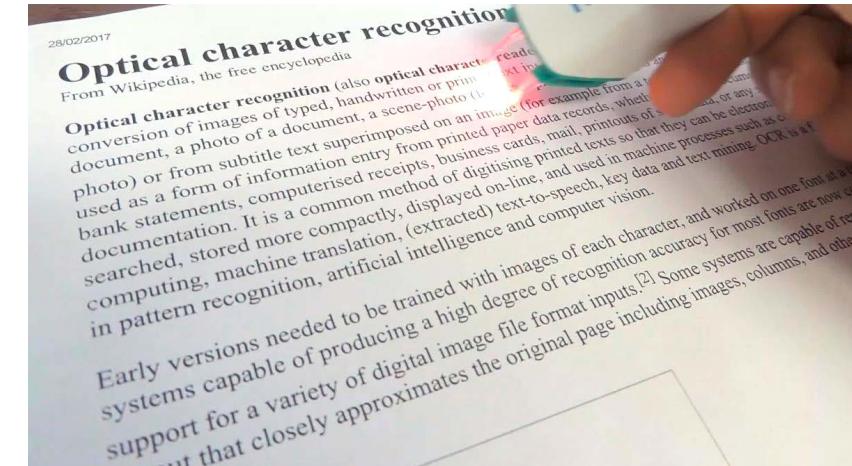
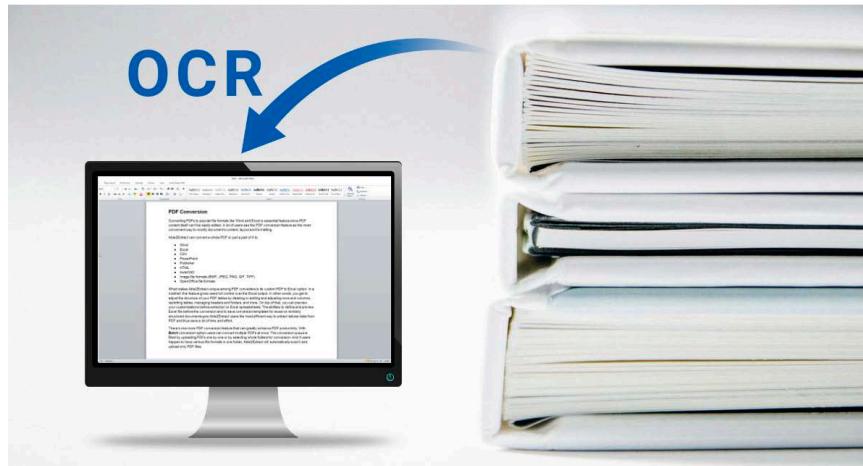
# Magnetic Ink Character Recognition (MICR)

- MICR is a character recognition system that uses
  - special ink contains magnetizable particles of iron oxide
  - characters that are from a **special character set**
- MICR is used by banks for faster processing of large volume of cheques
  - bank's identification code (name, branch, etc.), account number, and cheque number are pre-printed (encoded)



# Optical Character Recognition (OCR)

- Scanner with a character recognition software (called **OCR** software) that converts the bit map images of characters to ASCII codes
  - enable word processing of input text
  - require less space for storing the document
- OCR software is extremely complex because it is difficult to make a computer recognize an unlimited number of fonts



# Image Capturing Devices

- Digital cameras
  - Images recorded digitally on disk or in camera's memory
  - Images can be downloaded to a computer
- Digital video cameras
  - Records motion digitally, can also take still images
  - WebCams: specialized digital video cameras built-in or attached to the monitor



Digital camera



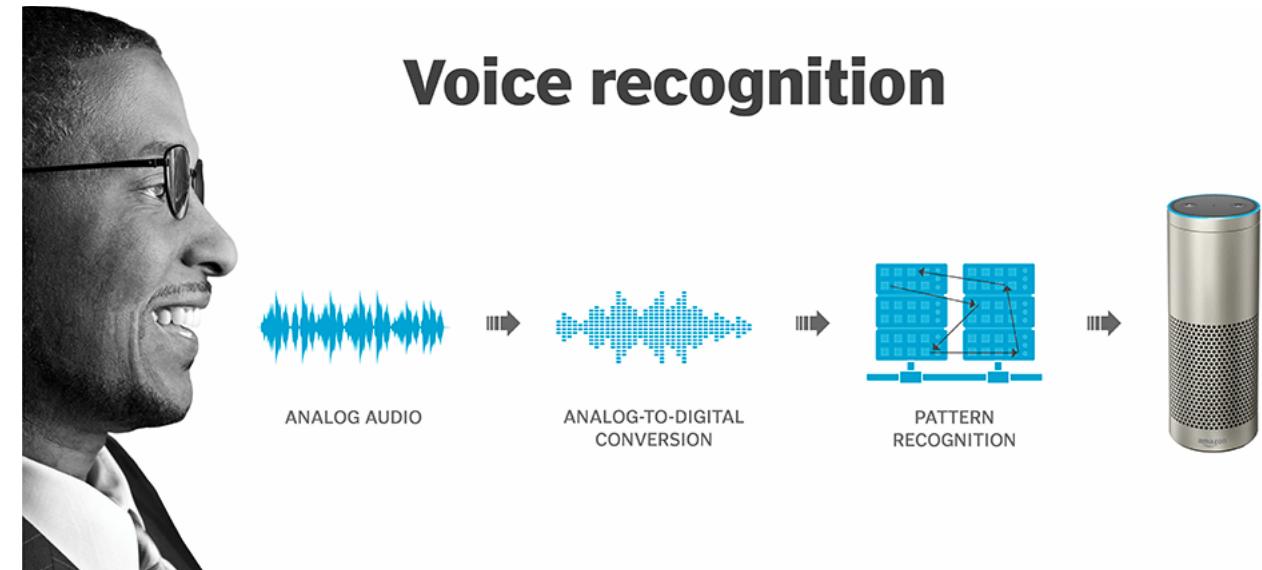
Webcam

# Audio-Input Devices

- Voice recognition: enable a computer to distinguish spoken words
  - Use a microphone, sound card, and special software
  - Users can operate computers and create documents using voice commands



Interaction by voice recognition



Voice recognition process

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# Output Devices

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- Monitors
- Projectors
- Audio output
- Printers

# Monitors

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- A monitor is an electronic output device in which the images and texts generated by means of a graphic or video adapter are displayed
- Features
  - Size
  - Resolution/pixels
  - Contrast ratio
  - Aspect ratio
  - Dot pitch



# Monitors

- Different types of monitors
  - CRT (cathode ray tube) monitor
  - LCD (liquid crystal display) monitor
  - LED (light-emitting diodes) monitor
  - OLED (organic light emitting diodes) monitor
  - etc.

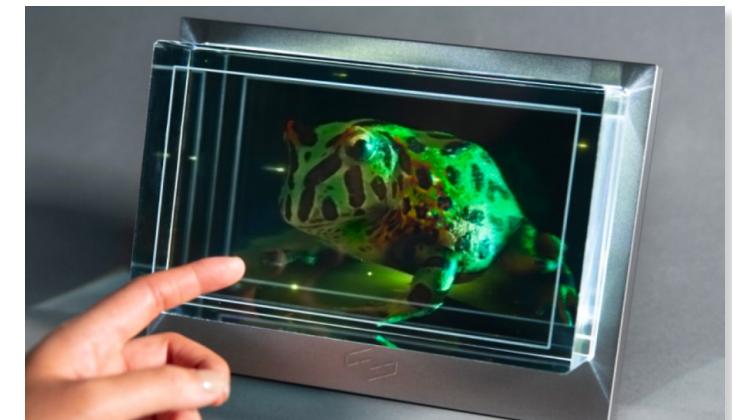


CRT monitor



# Monitors

- New display technologies
  - Curved display
  - See-through display
  - Flexible display
  - Holographic display
  - etc.



# Projectors

- A device that projects computer output onto a white or silver fabric screen that is wall, ceiling or tripod mounted.
- Widely used in classrooms and auditoriums for instruction and slide presentations



# Audio Output

- A **computer speaker** is an output device that connects to a computer to generate sound.
- The signal used to produce the sound that comes from a computer speaker is created by the computer's **sound card**



Sound card



Computer speaker

# Printers

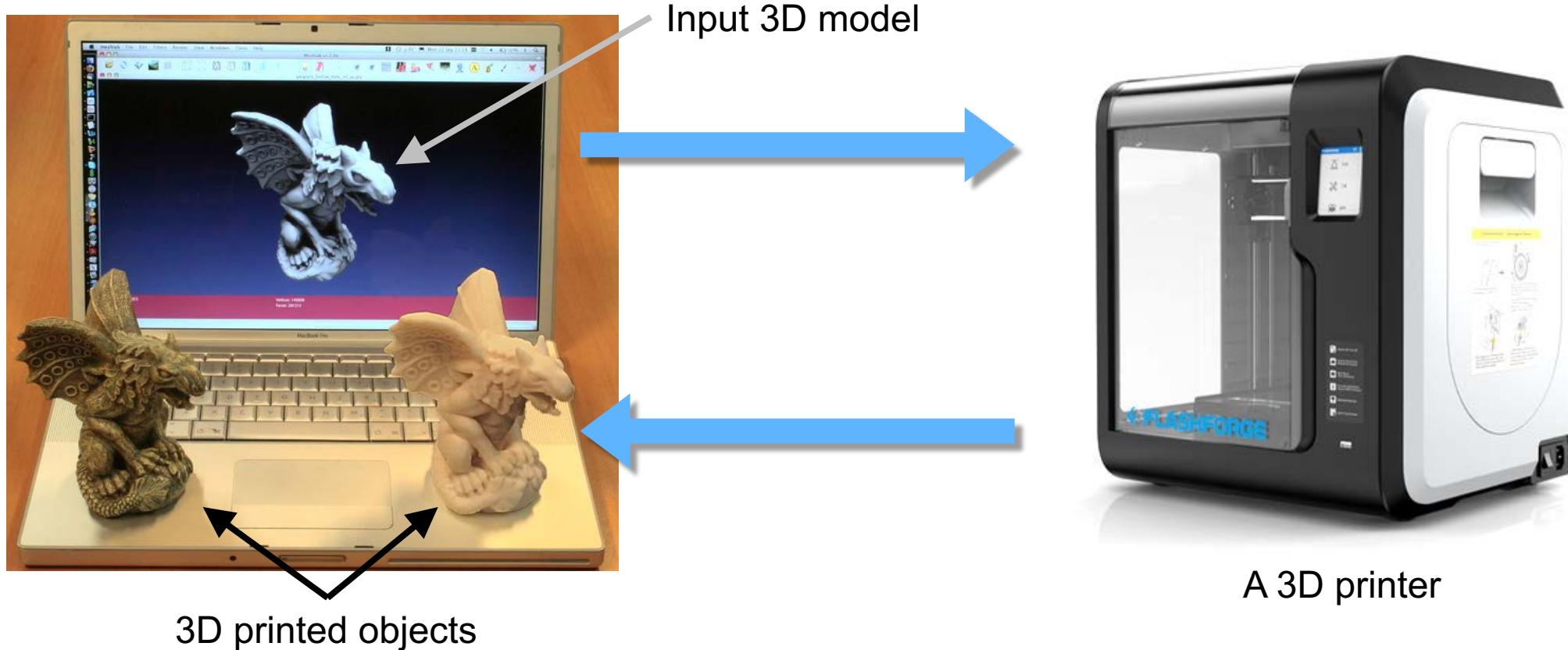
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- A printer is an output device which makes a persistent representation of graphics or text, usually on paper
- Features
  - Resolution
  - Color
  - Speed
  - Memory
  - Duplex printing



# Printers

- A **3D printer** is an output device that builds a 3D real object from a 3D virtual model, usually by successively adding material layer by layer



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# Integrated Input & Output Devices

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- Smart phones
- Haptic devices
- Data gloves
- Wearable devices

# Smart Phones

- Smart phones are a class of multi-purpose mobile computing devices
  - *Input:* virtual keyboard, multi-touch screen, digital camera
  - *Output:* touch screen display, speaker, vibration



Smart phone



Interact with a smart phone

# Haptic Devices

- A haptic device provides tactile sensation to human interaction with computers
  - *Input:* a handle to specify 3D position/orientation
  - *Output:* force feedback on the hand to simulate the tactile sensation



A typical haptic device



3D modeling with a haptic device

Youtube Link:  
[https://www.youtube.com/watch?v=C\\_rHAbJJggM](https://www.youtube.com/watch?v=C_rHAbJJggM)

# Data Gloves

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- A data glove is an interactive device, resembling a glove worn on the hand, which facilitates tactile sensing and fine-motion control in virtual reality and robotics
  - *Input:* movement of hand and fingers
  - *Output:* sense of human touch, including pressure, force, torque, temperature



Youtube Link:  
<https://www.youtube.com/watch?v=xWeqrAw0QRw>

# Wearable Devices

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- Wearable devices are smart electronic devices that can be incorporated into clothing or worn on the body as implants or accessories.
- Example #1: Apple watch
  - *Input:* multi-touch screen, digital camera
  - *Output:* touch screen display, speaker, vibration



# Wearable Devices

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- Wearable devices are smart electronic devices that can be incorporated into clothing or worn on the body as implants or accessories.
- Example #2: Google glass
  - *Input:* touch pad, digital camera
  - *Output:* optical display, speaker



# Thank You!

(This is the last lecture of UI course)