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Output devices



The ultimate display?

"The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal." (Ivan Sutherland, 1965)

We are not yet there ...

There are a lot output devices
for a lot of different applications
Visual displays:

RATE / MIN	999999
TOTAL COUNT	999999



Less conventional visual displays



What future?



<https://vrscout.com/news/snapchat-reveals-next-gen-ar-glasses/>
(May, 2021)

And not only to produce visual displays...

<http://www.geomagic.com/en/products/phantom-omni/overview>

sound



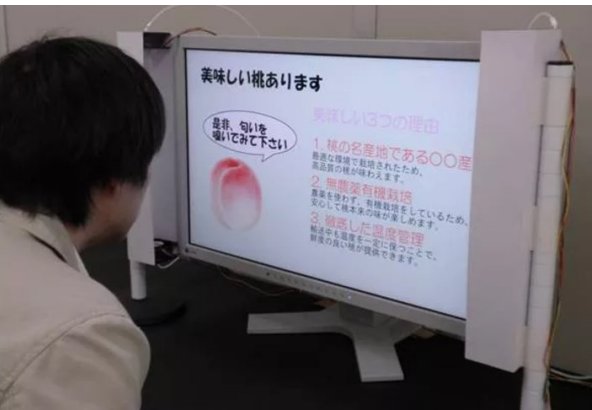
Touch and force feedback

<http://www.cyberglovesystems.com/cyberglove-ii/>

smell



<https://vrscout.com/news/olfactory-engineering-scent-based-vr/>



Graphics/visual Displays

Are computer interfaces that present images to one or several users

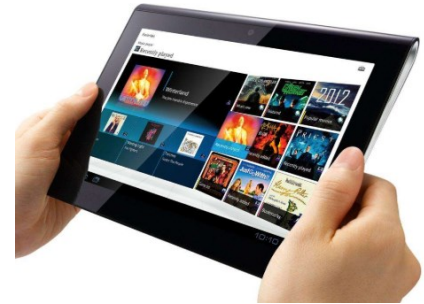
A possible taxonomy:

- Personal displays:
 - monitors
 - HMDs (VR/AR)
 - Binoculars
 - Monitor-based displays/active glasses
 - Autostereoscopic displays
- Large volume displays:
 - Caves
 - Walls
 - Domes
 - ...

Personal Displays

The images may be monoscopic or stereoscopic, monocular (for a single eye) or binocular (displayed on both eyes).

- Screens of various sizes
- Head Mounted Displays (HMDs)
- 3-D Binoculars (hand supported)
- Auto-stereoscopic displays
(desk supported)



Large-volume displays

- CAVE type displays
- Wall-type displays
- Domes
- ””

<http://www.mechdyne.com/cave2.aspx>



- Main technologies:
 - LED displays (several types)
 - LCD displays
 - Autostereoscopic displays: lenticular/barrier
 - ...
- Other technologies:
 - electrophoretic,...

https://en.wikipedia.org/wiki/E_Ink



- **Images provided by computer monitors are poor when compared to the real world**
- **It is amazing what we get from such simple devices**
- Monitors have several limitations:
 - Small range of intensities and colors
 - Lack of focusing distance
 - Small field of view
 - ...



Voice synthesizers

- There are several types:

Digitized - concatenates recorded basic sounds

Synthesised – concatenates sounds generated with models

- There are several technical challenges due to the nature of human voice:

different pronunciation rules

meaning may be changed by intonation

differences in intonation reflect different moods

- **The quality of a synthesizer implies much more than intelligibility**

Advantages of using voice output:

When the user has:

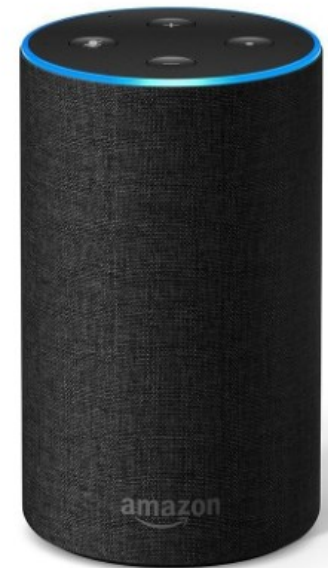
- physical deficiency
- to move around
- hands and eyes busy
- Adverse conditions: low visibility, low O₂, high Gs

Disadvantages:

- Is tiresome and uncomfortable for long periods
- Is transient (taxes STM)
- May have privacy issues
- May disturb other people

Examples of using voice input/output and natural language interaction style:

- Siri
- Alexa
- Google Home
- Google Duplex

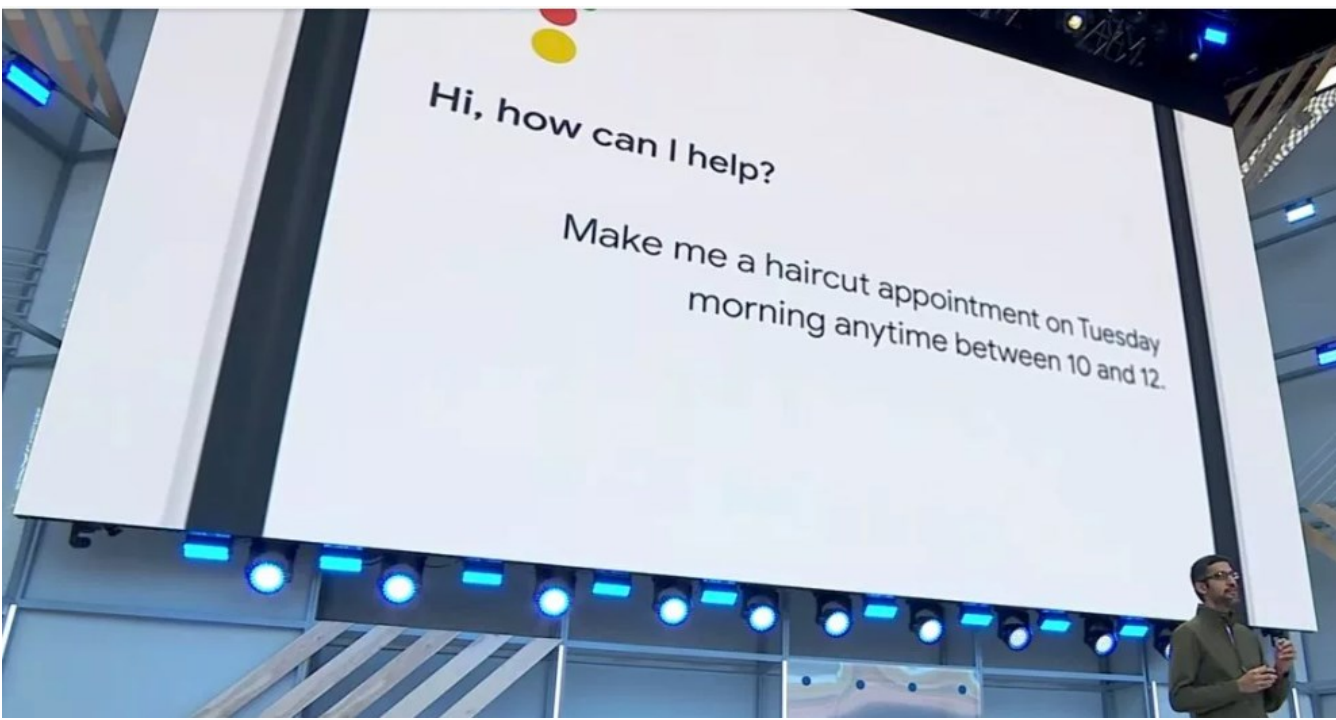


https://en.wikipedia.org/wiki/Amazon_Alexa

Google Duplex

Is a culmination of various efforts over the years in deep learning, natural language understanding, speech recognition, and text-to-speech.

“In the domain of making appointments, it passes the Turing test ... which is an extraordinary breakthrough. It doesn't pass it in the general terms ...”



<https://9to5google.com/2018/05/21/google-duplex-explained-turing-test/>

Some guidelines to use voice output

- Consider voice output as an alternative when the user must move around, has hands and eyes busy
- Avoid voice output in open environments, when the privacy and security are important issues and frequency of usage is high
- Use approx. 180 words per minute
- When messages are not expected, start with non-critical words that provide context
- Say first the goal and then the solutions
- Allow messages to be repeated

Example: Medical VR Total Knee Surgical Simulator Demo



<https://ghostproductions.com/medical-vr-virtual-reality/surgical-training/>

A glimpse of the future? Interactive live holography

<http://realviewimaging.com/technology/>



Conclusion

- **Technology shall not be used only because it is new!**
- **Independently from the type or state of the art of the input / output devices it is necessary to understand their usability for different types of users, tasks and context**