Virtual Reality Systems

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Outline

Second Part:

- Hearing (HRTF, 3D Sound)
- Touch (Haptic Feedback, Feeling)
- Smell (Chemical, Electrical)
- Emotion (Heart beat, Muscular activity, Camera)
- Locomotion (Software, Hardware)
- BCI (Disabled Person, Power of thought)
- Future
Hearing (HRTF, 3D Sound)

- Head-Related Transfer Function (HRTF)

Binaural Recording

3D Sound in real time according to your location

Barber Shop Video: https://www.youtube.com/watch?v=8IXm6SuUigI
Touch (Haptic Feedback, Feeling)

• Glove with Haptic Feedback by Herbert Shea, head of EPFL’s Soft Transducers Laboratory (LMTS)
Touch (Haptic Feedback, Feeling)

- Multimodal Haptic Device design by Dr. Rognini from EPFL Laboratory LNCO

It may “provide multimodal tactile feedbacks such as temperature, pulse, tapping pressure or variable compliance as well as force feedback in one single device. “

Patent : US 2016/023804.0 A1 published by Dr. Rognini from LNCO
Touch (Haptic Feedback, Feeling)

- Commercial Solutions

Haptx

Tesla Suit
Emotion (Heart beat, Muscular activity, Camera)

• Facial Tracking

MindMaze Mask, Startup founded by Dr. Tej Tadi from EPFL
Emotion (Heart beat, Muscular activity, Camera)

- Facial Tracking

Facial Tracking from Oculus Research
https://youtu.be/VCd1aRrilis
Emotion (Heart beat, Muscular activity, Camera)

• Eye Tracking

Infrared Light is sent in the user’s eye (Light Ring in the headset) and reflected (see below). The corneal reflection is recorded by a camera.

Visible light: center of iris (red), corneal reflection (green), and output vector (blue). (from Wikipedia)

Eye tracking module in the HTC Vive made by Tobii
The computer game was dynamically modified by the player’s biometric information to increase the cinematically augmented “horror” affordances.

The more you are afraid the more the game becomes easy.

=> Adaptive difficulty of the game according to your emotion

ECG HRV (Electrocardiogram Heart rate Variability) and the GSR (Galvanic Skin Response) of a player is recorded in real-time.

“Peripheral vestibular organs in the inner ear consist of otoliths, i.e., utricle and saccule, which sense linear acceleration, and semicircular canals, i.e., anterior, posterior, and horizontal canal, which sense rotational acceleration. The vestibular nerve projects signals from otoliths and semicircular canals to the central nervous system.”

**Locomotion (Software, Hardware)**

- **Galvanic Vestibular Stimulation**

  Headband which sends an electric signal to stimulate the vestibular nerve thanks to three electrodes placed around your skull.

  Headset which generates a magnetic field to stimulate the otolith organs.

  Example: [https://www.youtube.com/watch?v=B2uXNxBZs](https://www.youtube.com/watch?v=B2uXNxBZs)
Locomotion (Software, Hardware)

- Bone Conduction Vibration

Headband which creates non-specific continuous vibration. These vibrations are sent to the inner ear through bone conduction. This vibration will disturb the vestibular system in order to avoid any motion sickness.

Headband from OtoTech
Locomotion (Software, Hardware)

• Treadmill

Katwalk VR: https://youtu.be/cHo8wy-_SOI

Infinadeck: https://youtu.be/RyFof9GpWac
Redirecting Walking

“The user walks in the real environment on a different path with a different length in comparison to the perceptual path in the virtual world”
Locomotion (Software, Hardware)

- Redirecting Walking


Video: https://youtu.be/eDk4HrEtGrM
Locomotion (Software, Hardware)

• Examples of new locomotion in game (replace full locomotion)

Arm Swing from Natural Locomotion

Teleport from Budget cuts
Smell (Chemical, Electrical)

• Chemical

Scented water vapor guided to the user’s nostrils via an ultrasound-driven flow.

Smell (Chemical, Electrical)

• Electrical Stimulation

(A) An endoscope (green arrow) was used to guide the electrode through an endoscopic working channel. Two Teflon tubes were positioned at the entrance of the stimulated nostril: one for delivering odors from an olfactometer (blue arrow), and another for measuring nasal airflow (red arrow).
Smell (Chemical)

• Commercial Solution

VASQO VR

Feelreal VR
They produce and modify thermal taste sensations on the tongue by modifying the temperature of the surface of the tongue within a short period of time (from 25 °C to 40 °C while heating, and from 25 °C to 10 °C while cooling).

- "rapidly heating the tongue produces sweetness, fatty/oiliness, electric taste, warmness."

- "cooling the tongue produced mint taste, pleasantness, and coldness."

Taste (Chemical, Electrical)

• Chemical Solution

They change the taste of the cookie by changing the combination of scent and texture to overlay on the cookie. If you show a chocolate cookie and send a chocolate scent whereas he is eating a normal cookie without flavour, the person will perceive a chocolate flavour for the cookie.

The olfactory display can eject fresh air and seven kinds of scented air.

BCI (Disabled Person, Power of thought)

• Disabled Person
BCI (Disabled Person, Power of thought)

- Rehabilitation

“Implementation of a BCI system that controls the ambulation of an avatar within a virtual reality environment (VRE).”

“By using a data-driven machine learning approach to decode the users’ kinesthetic motor imageries (KMs), this BCI-controlled walking simulator enabled” users to control an the legs of an avatar.

T. P. Luu, Y. He, S. Brown, S. Nakagome and J. L. Contreras-Vidal, "A closed-loop brain computer interface to a virtual reality avatar: Gait adaptation to visual kinematic perturbations,"
BCI (Disabled Person, Power of thought)

• Commercial Solution

Emotiv from EPOC

Commercial Prototype from Mindmaze
Future

• Foveated Rendering

Realtime Rendering with eye tracking

• 3D Scan

Realtime 3D reconstruction

• Immersed your own body

Realtime Animation
Questions ?