

Full Body, Olfactory, Gustatory Technologies

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Full Body Interfaces: Overview

- Body systems
- Classification
 - motion platform
 - self motion
- Full Body Technologies

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Full Body Interfaces: Mechanisms

- Vestibular system
 - orientation to vertical
 - centre of mass control
 - head stabilization
 - direct to spinal cord (vestibular-spinal reflex)
 - vestibular-ocular reflex
- Visual system
 - position and movement of head
 - slip of retinal image (optokinetic reflex)

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Full Body Interfaces: Classification

- Passive Motion Platforms
 - cabins
 - chairs
 - centrifuges
 - examples (first practical VR applications):
 - flight simulators
 - games
- self-motion interfaces
 - user moves self through VE
 - active movement
 - alternative to “flying” interfaces

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Full Body Interfaces: Classification

- Want surface characteristics
 - slope, resilience and texture
- want sense of effort for locomotion

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Passive Motion I/F (Commercial)

- CAE Flight Simulator
- Chairs in motion
 - Cyber Air Base, Cyberchair, CyberMotion Seat, IntelliSeat, Sim245
 - pneumatics or motors



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Passive Motion I/F (Commercial)



Photo courtesy of Village, Inc.



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Photo courtesy of CuckooMotion International plc



Photo courtesy of Fugate Corporation



JoyChair (Kawada)



Photo courtesy of Torus Systems, Inc.

Self Motion Interfaces: Commercial Products

- \$8K - \$55K
- Gyroscopes
 - Aerotrim, CyberTron, Orbotron, X-otron VR, Supertron
- Hang glider
 - DreamGlider
- Interactive Motion Platforms
 - PemRAM 3 & six axis motion base
- SimuPod and SimuSled

Self Motion Interfaces: Commercial Products



Photo courtesy of Aerotrim USA, Inc.



Photo courtesy of Deme Developments, Ltd.

- Hollerbach (Utah)

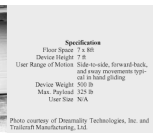


Photo courtesy of Densault Technologies, Inc. and Tridient Manufacturing, Ltd.

Self Motion Interfaces: Commercial Products

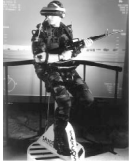


Photo Courtesy of Sarcos Research Corporation



Photo Courtesy of Sarcos Research Corporation



Photo C. courtesy of Sarcos Research Corporation

Self Motion Interfaces: Research

- Some of the same companies that are making products also do the research
- Locomotion Interface
 - Hollerbach
- Hiroo Iwata (Tsukuba)
 - Haptic Walkthrough Simulator
 - modified roller skates
 - Probably group that makes terrain feedback
 - triangular segments controlled by hydraulic motors

Self Motion Interfaces: Swimming Across the Pacific

- swimming interface using VR technology
 - hct.ece.ubc.ca/research/sap



Self Motion Interfaces: Birdly

- Birdly: Zurich University of the Arts
 - now its marketed by: <http://www.somniacs.co>



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Full Body Motion Interfaces: Summary

- Large systems dedicated to one task is effective
 - flight simulators
- Other uses
 - arcade games
 - military training
- Infancy of research

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Olfactory Interfaces

- One of least developed
 - applications
 - poorly understood
 - social mores
- Useful for
 - fire fighting
 - surgical training
 - immersion
 - manipulate mood
 - increase vigilance
 - decrease stress
 - retention and recall of material

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Olfactory Mechanisms

- Usually air with smell goes into nose then into nasal cavities (as large as brain)
- volatile chemicals interact with various sensors in nose
 - olfactory epithelium (top of cavities)
 - connected to olfactory bulb to nerves
 - cells regenerate every 30 days
 - trigeminal stimulation (i.e. cooling effect)
 - vomeronasal organ, also known as Jacobson's Organ
 - close to entrance; pheromone sensitive
 - rich history
- check out: Kaye, J.: web.media.mit.edu/~jofish/thesis/

Olfaction: Artificial Mechanisms

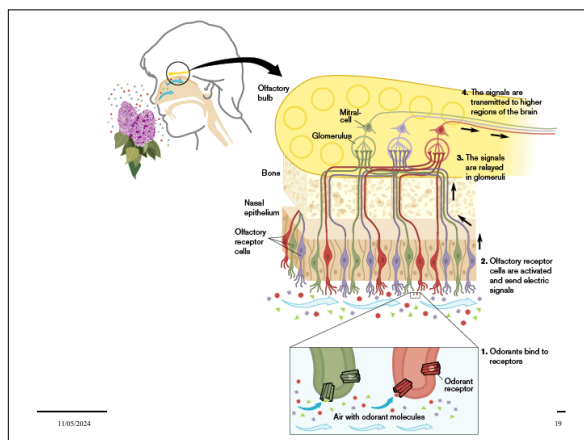
- Electronic noses
 - conductive sensors: metal oxides/polymer sensors
 - mass changes: Absorbent polymers
 - mass measured with either SAW or quartz crystal microbalance
 - Metal-oxide-silicon field-effect-transistor
 - (Nagel, Schiffman and Guitierrez-Osuna 1998)
 - optical methods
 - Tufts, (Schmiedeskamp 2001)
 - (Rakow and Suslick 2000, Dagani 2000)



Figure 4. Digital smell camera (Rakow and Suslick 2000).

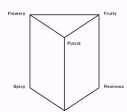
How do we smell?

- Wright's Vibrational Theory
 - absorption peaks in their far infrared spectra
- Amoore's Stereochemical Theory
 - lock-and-key mechanism
- Turin's Spectroscopic Theory
 - vibrational sensing through inelastic electron tunneling
- Chiral Molecules
 - more complexities for smell than covered by any current theory
- Protein receptors (Axel and Buck, 1991)
 - Controlled by >1000 genes



Olfactory Classification

- Lots out there:
 - Nothing accepted yet
- six category prism (Henning 1915)
- cultural classifications
 - i.e. pungent-smelling old men, old women, large mammals, macaw, some amphibians, medicinal plants
- Perfumery (Curtis and Williams 1994)
 - set of three letter codes
 - often trade-secret
- Domain specific
 - beer, wine and spirits



Wine wheel



Olfactory Psychophysics

- How many can we distinguish?
 - Not clear
 - 1.5 bits to 10+ bits; 10,000 different smells
- How much?
 - Intensity measures
 - complicated by habituation
 - context sensitive
- very sensitive 1ppm to 1ppb
 - 15% to 30% change is detectable (closer to log than linear)

People and smell

- Emotional effect
 - not clear, cultural effects, non-repeatable
- Smell can evoke memories
- Impact sleep?
- Attraction and synchronization
 - pheromones

Olfactory Displays: Products

- Aromatron - what we want to create
- Scratch & Sniff
- DigiScents (bankrupt)
 - smell index (100-200 smells)
- TriSenx (bankrupt)
 - single smell controlled by serial port
- BOC Group Olfactory Delivery Systems
 - dissolve odorants in gas
- Smell Enhance Experience System
 - seven odors in liquid form
 - delivered with small tube
- Smell-o-Vision (K Opticom)
 - 6 gels, USB controlled
- Aroma 2100



Olfactory Displays: Research

- DIVEpak (Southwest Research Institute, 1993)
 - 8 odors
 - contained in cartridge
 - heated and dissolved in air
 - blown at user
- E. Piaggio BioRobotic Lab (U. of Pisa)
 - smell camera
- Artificial Reality Corporation
 - developing odorants
- Marketing Aromatics, Ltd.
 - Aromatic oils vapourized

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Some Olfactory Research

- Joe Kaye:
 - inStink
 - inTouch concept except with smell
 - CO2 through air brushes
 - Dollars & Scents
 - ambient media
 - perfume spray bottles
 - Scent Reminder
 - 5 channel D & S device
 - and more...

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Olfaction Research

- Gauthier and Smith (HIT 02)
 - interactive yoga system
 - 3 aromatherapy diffusers
 - controlled through X10 protocol
 - turn on according to yoga postures
 - mixed with ambient sound and image according to Kundalini yoga theory



Responses in Light, Sound and Scent

A Therapeutic Interactive
Yoga System

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Olfactory Displays

- Storage media
 - liquid, gel or waxy solids
 - microencapsulate odorants
 - scratch and sniff
 - drops of liquids encapsulated in gelatin
 - placed using silk screening
- Display
 - air dilution
 - breathable membranes
 - liquid injection with air flow control

Olfactory Displays

Table 20. Olfactory Delivery Technologies^a

Storage Technologies	Presentation Technologies	Advantages	Disadvantages
Liquid	• Unswamped concentration Saturated cotton balls Waxtable membranes Permeation tubes Bubble chambers	• No power • Inexpensive	• Bulky • Odorants clumsy to handle
	• Heat induced evaporation	• Inexpensive	• Power hungry
Gels	• Electrostatic evaporation	• Good for large masses • Materials easy to handle	• Never miniaturized • Requires higher voltages
Microencapsulation	• Mechanical release	• Could be valveless • Materials easy to handle	• Mass production technology • Impractical for small lots
	• Heat release	• Could be valveless • Materials easy to handle	• Mass production technology • Impractical for small lots
	• Valve design options: No valves	• Smaller, cheaper	• Interconnection of odors
	Off-the-shelf valves	• Mass produced	• Bulky, never hungry • Fast or precise, not both
	Ink jet printer nozzles	• Precise control	• Single units large because of packaging
	Microvalves	• Potentially fast & small	• Must make custom manifolds to get greatest miniaturization

a. Based on Krueger (1995, 1996).

Olfactory Displays

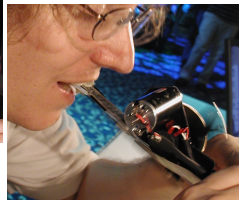
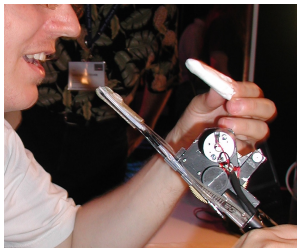
- Challenges
 - clean air input
 - evacuate air
 - clean output air
- control breathing space
 - sealed room with air filtration
 - air control in front of and behind user
 - sealed pod
 - tethered mask
 - tubes into an HMD from pack
 - built into HMD

Gustatory Display

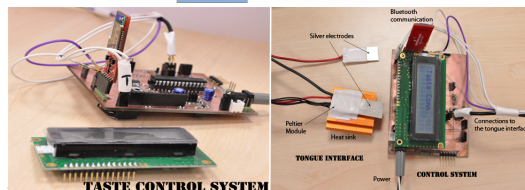
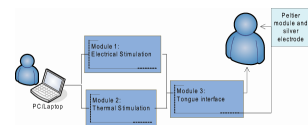
- Not much out there...
 - One performance at Opera Totale 4 by Beneton group
 - four biscuits of different colour that you ate
 - Iwata, Siggraph03
 - bite feedback and simulated taste/sound (apple and cracker)
 - Chemicals for synthetic flavour
- research topic
 - recording device?
 - Artificial tongue
 - display device?
 - Delivery mechanism
 - remove taste mechanism
 - human factor issues



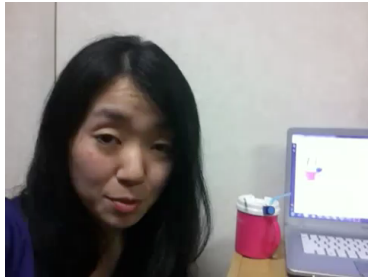
Iwata's Bite Simulator



Digital Taste Interface (Ranasinghe & Cheok, 2012)



Another gustatory display



Nakamura & Miyashita, 2011

and one more... TransFork



Ying-Li Lin (National Taipei University of Technology), Tsai-Yi Chou, Yu-Cheng Liao, Yu-Cheng Huang, Ping-Hsuan Han, VRST2018
https://www.youtube.com/watch?v=htHXi_b6MAg

Olfactory Displays: Summary

- Look forward to research
- still very new and understudied

Summary

- Human body is amazing
 - making displays for all parts is goal of much research
 - desire to make virtual reality
 - better “visualization” of information
 - better control of information
 - expression
 - fun
- Lots of room for research