PERCEPTUAL COMPUTING
COMPUTER VISION

PI03 @ Mobile HCI

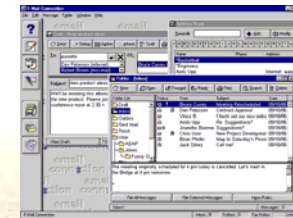# Sensing Opportunities for Physical Interaction

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http://www.vision.ethz.ch/pccv

ETH

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Swiss Federal Institute of Technology Zurich

Approaching Physical Interaction

- **real world: natural interaction**

- **computers: virtual interaction**

- **integration of both worlds: Physical Interaction**
  - **devices/wearables**
    - sensors, computing and communication
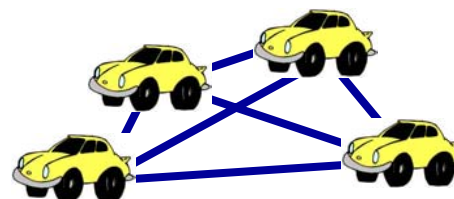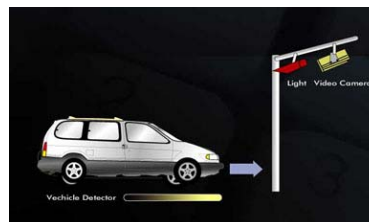 - **objects/environments**
    - sensing and displaying information

-> What are the appropriate sensors?

Logical View: Dimensions of Sensing

interaction degree

activity

ID

Quality of Perception

use of objects

location

Biometric signs
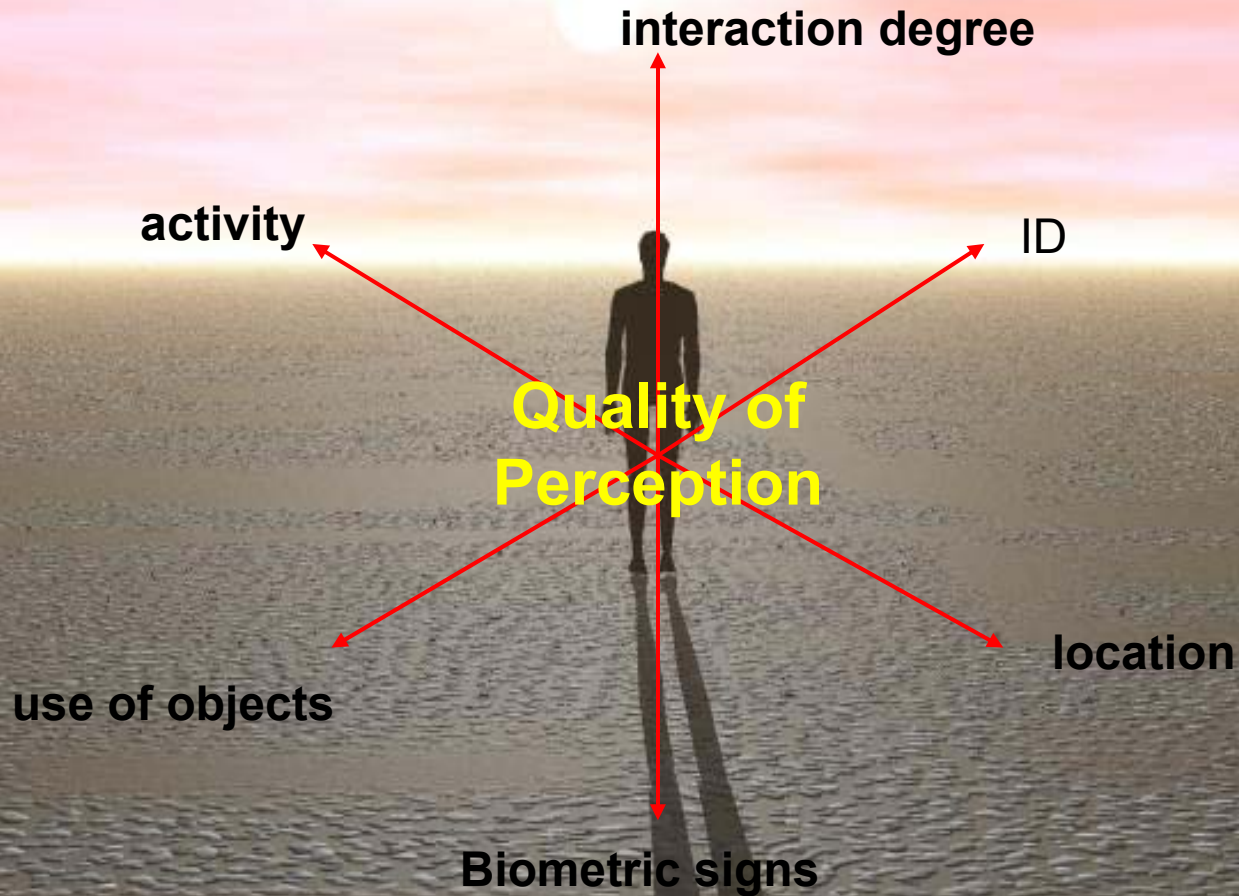
Physical View: Placement of Sensors

- **in environment**
  - ➤ hidden
  - ➤ works with all users
  - ➤ often indirect
- **on human**
  - ➤ obvious to user
  - ➤ works in all environments
  - ➤ direct
- **on object**
  - ➤ works in objects proximity
  - ➤ depending on object's properties
    - – present-to-hand (*vorhandensein*) vs. ready-to-hand (*Zuhandensein*)
- **mutual colloboration**
  - ➤ direct
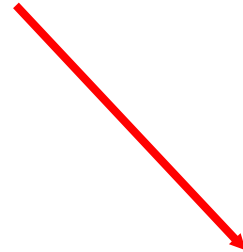 - ➤ works in instrumented environments with instrumented users

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present-at-hand
ready-to-hand

Placement	Quality of Sensing	Installed in Environment	On Object	On Human	Mutual Collaboration
ID	high	biometric sensing / vision / audio		audio	location systems
	low	load-cell	inertial sensors	inertial sensors	
Obj. Use	high	load-cell audio vision	inertial sensors / load-cell / force/distance/capacity	audio	location systems
	low	switch/lightbarriers	light	inertial sensors	
Location	high	load-cell / radar, laser Vision / PIR audio	GPS	GPS	location systems / diff. GPS
	low	switches, IR-barrier	pressure, humidity	pressure, humidity	
Bio/Emots	high	vision / audio	force/load / touch	GSR oximetry / inertial sensors / temperature	-----
	low				
Activity	high	Smart Board / Load-cell vision	-----	inertial sensors / strain strips	
	low	PIR, pressure, capacity		GPS	location systems
Interaction (humans)	high	Load-cells vision / audio	-----	inertial sensors vision / micro	-----
	low			GPS	
		Bandwidth low high	**Bandwidth** low high	**Bandwidth** low high	**Bandwidth** low high

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Discussion

Placement	In Environment	On Object	On Human	Mutual
ID	++	---	+	+
Obj. Use	o	++	+	o
Location	+	o / +	o / +	++
Bio/Emots	+	o	++	---
Activity	+	---	++	o
Interaction	+ / ++	---	+	o

--- not applicable, o possible, + good, ++ very good

Discussion

- each placement is meaningful for at least one dimension

- in environment & on human: best sensing results

- video & audio best suited for environment placement
  - ➢ computationally expensive
  - ➢ indirect measure

Placement	In Environment	On Object	On Human	Mutual
ID	++	---	+	+
Obj. Use	o	++	+	o
Location	+	o / +	o / +	++
Bio/Emots	+	o	++	---
Activity	+	---	++	o
Interaction	+ / ++	---	+	o

-- not applicable, **o** possible, **+** good, **++** very good

- on object: mostly inertial sensors

- high relevance of location in real-world
  - ➢ indirect measure for activity
  - ➢ best technology support (GPS, indoor systems…)

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Conclusion

- six dimensions of sensing represent sensing goals
- review of ubicomp research
- first step to systematize the use of sensors

- future work:
  - ➢ classifying combination of sensors
  - ➢ design space of sensors
  - ➢ sensor cookbook
    - – support for application designers
    - – sensor selection at run-time

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Thank you!

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Dimensions (cont.)

accel./gyro

video (face)
audio
biometrics
gang

activity

intent -
gesture-
posture-
gaze-
movement pat.-
movement-
sit, stand, lie: static-
idle-

video
audio
sound

human interaction
-group role
-discussion
-conversation
-talking
-collocation

ID
-fingerprint
-face
-voice
-gate
-height/weight
-presence

location

use of objects

RF-ID
IR-proximity
capacity
touch-force

—object relations
—object usage: purpose…
—object features
—object count
—presence
-living subj.

-phys. measures

-emotional state
-state prediction
Bio signs

—in-/outdoor
—direction
—moved distance
—relative loc. (obj.)
—absolute loc.
—semantic loc.

light
sound
temp.
pressure
GPS
RF-ID
knowledge

oximeter
galvanic skin
puls/temp.
face anal.