Politechnika Łódzka

Instytut Elektroniki

Electronic Interfaces Aiding the Visually Impaired in Environmental Access, Mobility and Navigation

Paweł Strumiłło

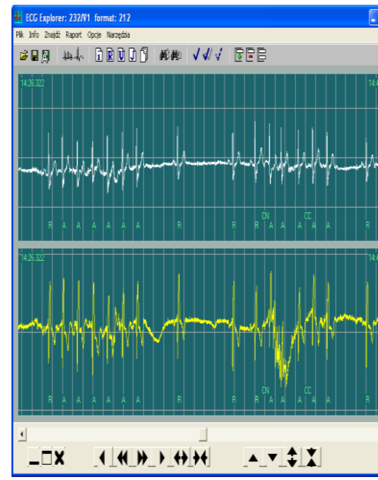
Medical Electronics Division

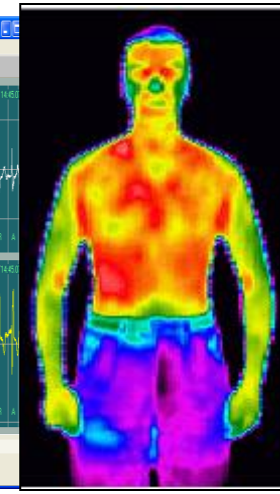
Lodz – the second largest city in Poland

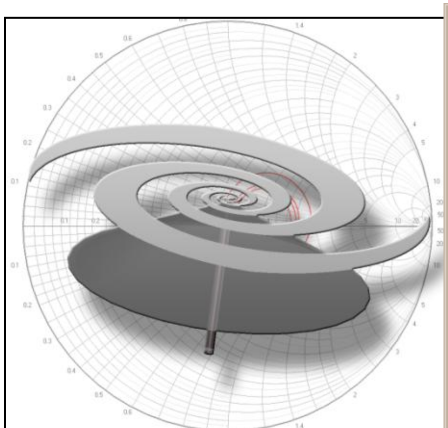
800 000 inhabitans
9 Universities

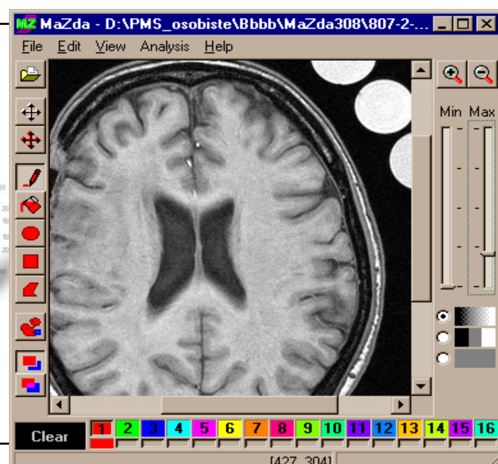
Institute of Electronics

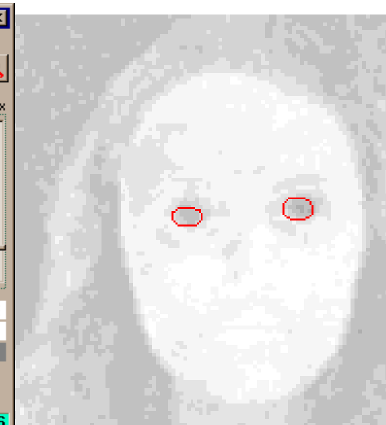
- ***medical electronics** (image and signal analysis), **human computer interfaces, assistive technologies for the disabled***
- ***electronic circuits and computed termography***
- ***telecommunication systems***

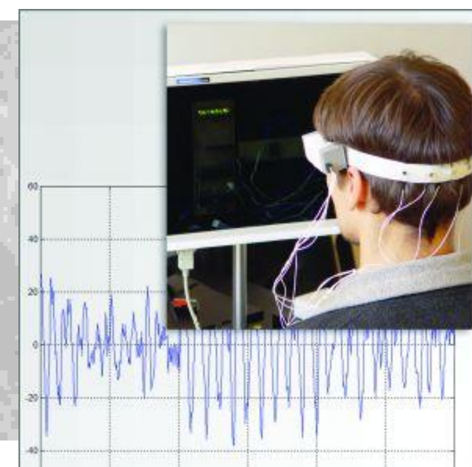












18.09.2008

Blindness

- ***Lack of sight is a loss of 80-90% perceptual abilities,*** *it affects other psychological functions*

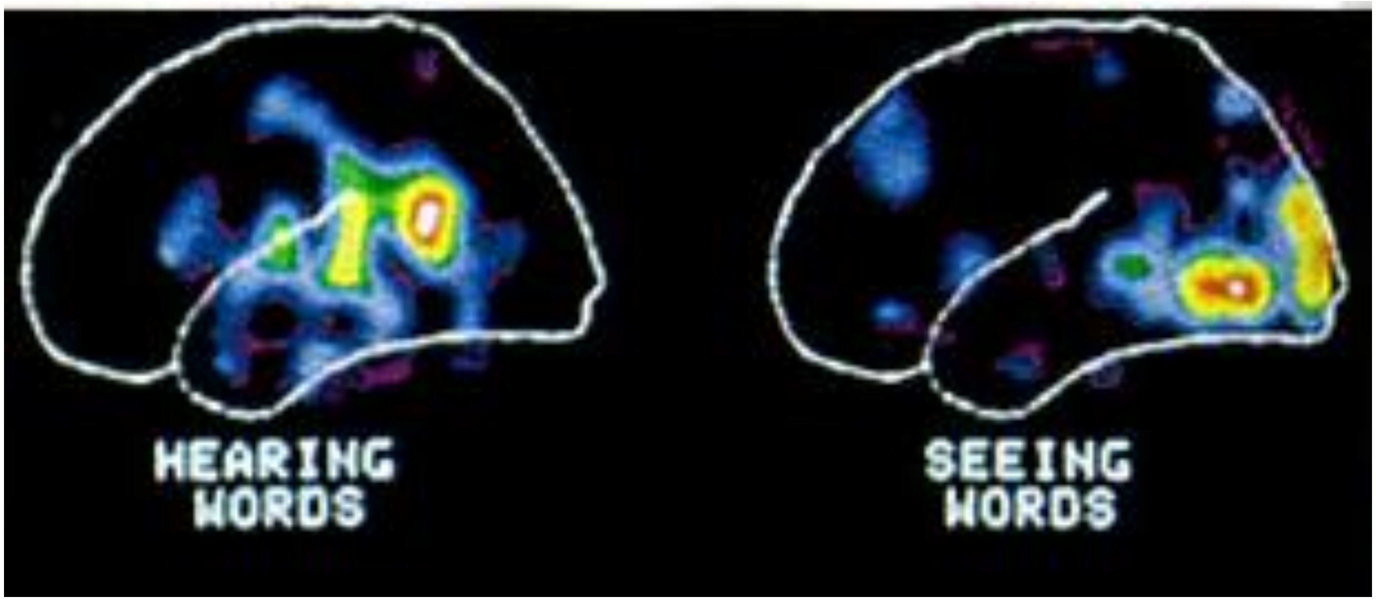
- ***Exclusion from social and professional life;***
  poor education, low employment rate

- ***Dependence on others***
  family, caregivers, guide dogs

- ***1 mln visually impaired in Europe (approx. 80 000 in Poland),*** *ageing demographics*

- *Annual cost in the USA:* ***68 bln $***

Blindness



Day-to-day problems of the blind

I. Safe and independent travel

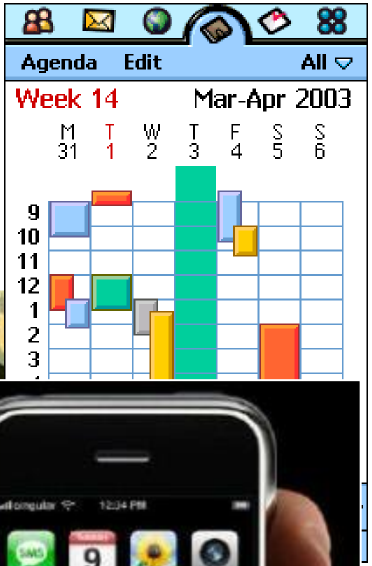
- *avoiding obstacles and pedestrians*
- *detection of surface discontinuities (stairs, curbs...)*
- *avoiding collisions with vehicles*
- *avoiding robbery and thefts, ...*

II. Navigation and orientation

- *orientation and spatial awareness*
- *identification of geographical location*

III. Access to information

- *text, graphics, GUI’s (information society)*

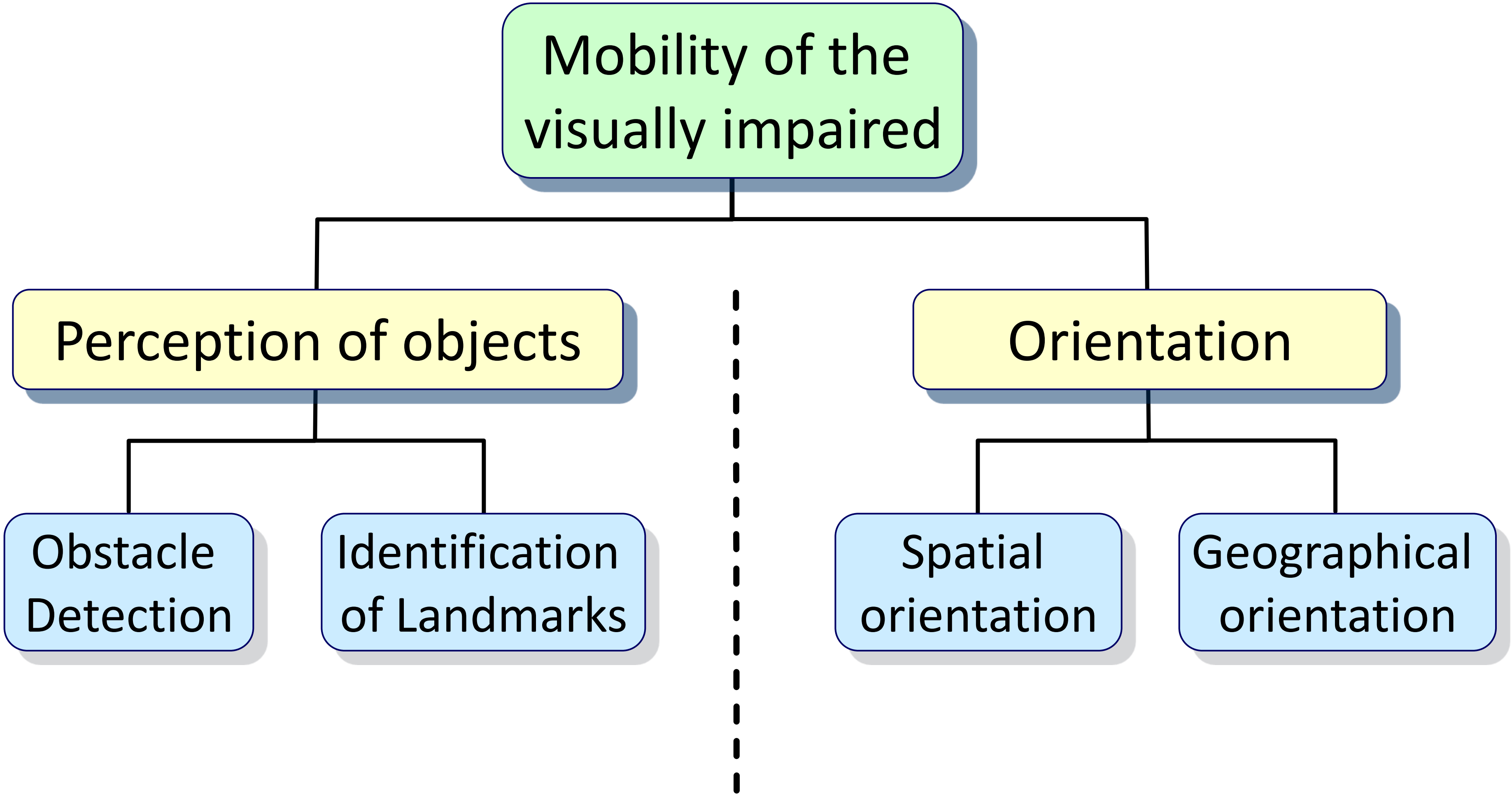


Mobility

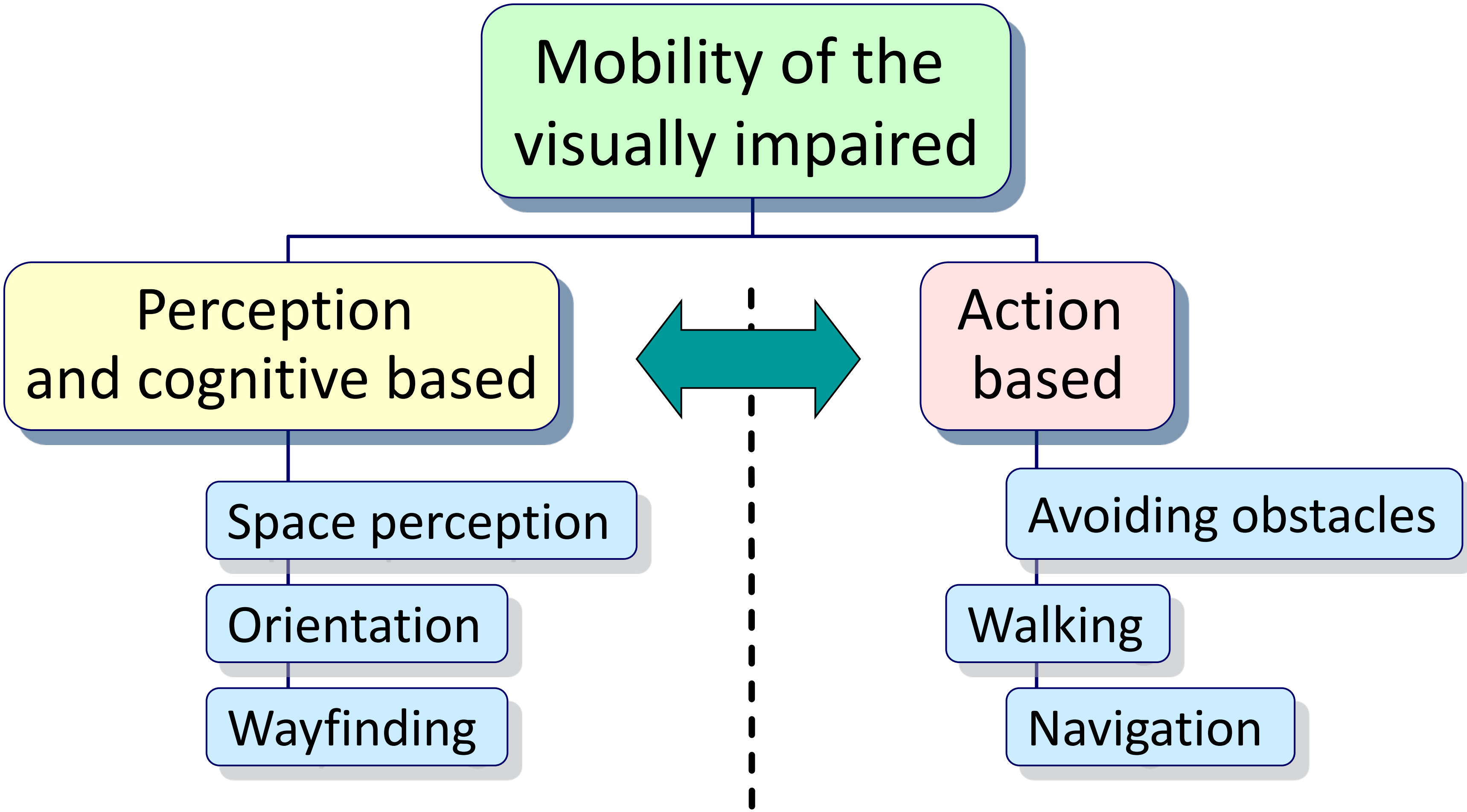
Mobility *- "… the ability to travel safely, comfortably, gracefully, and independently".*

E. Foulke, The perceptual basis for mobility, 1971

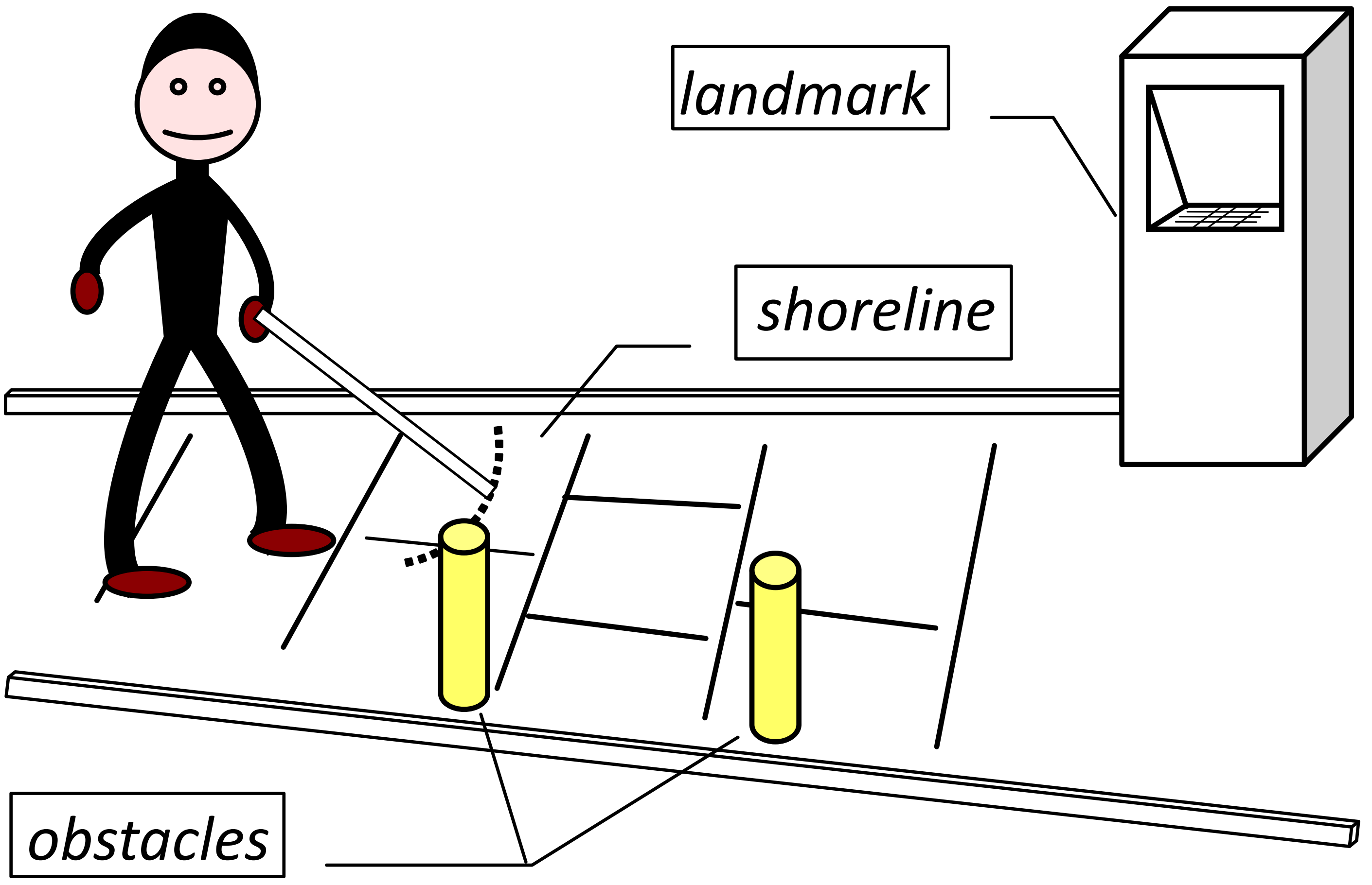
Brambing's model of mobility



Mobility



Mobility of the visually impaired
Perception and cognitive based
Space perception
Orientation
Wayfinding
Action based
Avoiding obstacles
Walking
Navigation


landmark
shoreline
obstacles

Primary mobility aids

+ human guide

***White cane** – used by almost all visually impaired*

<u>Pros:</u> cheap, good in detecting surface obstacles, informs others

<u>Cons:</u> 100 hours of training, hand-held, does not protect head

***Guide dog** – used by less than <1% of the visually impaired*

<u>Pros:</u> good in obstacle avoidance and following trained paths

<u>Cons:</u> very costly (~60 thousand USD), 6-years service

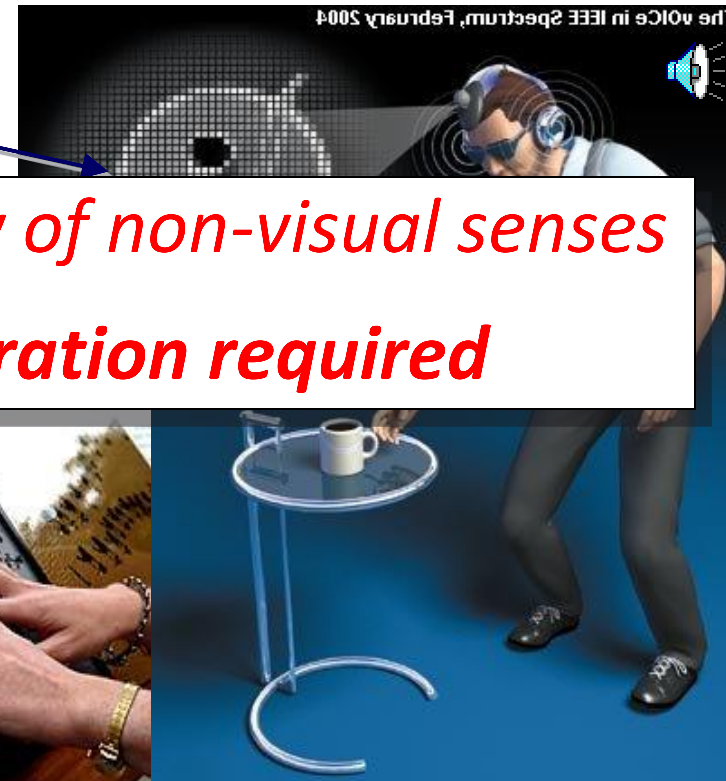
[Leonard Cheshire Disability]

Sensory substitution/supplementation

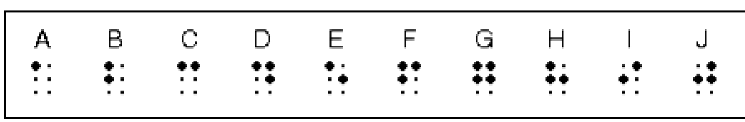
- ~~sight (80-90% information about environment)~~
- hearing
- touch

Lower information capacity of non-visual senses

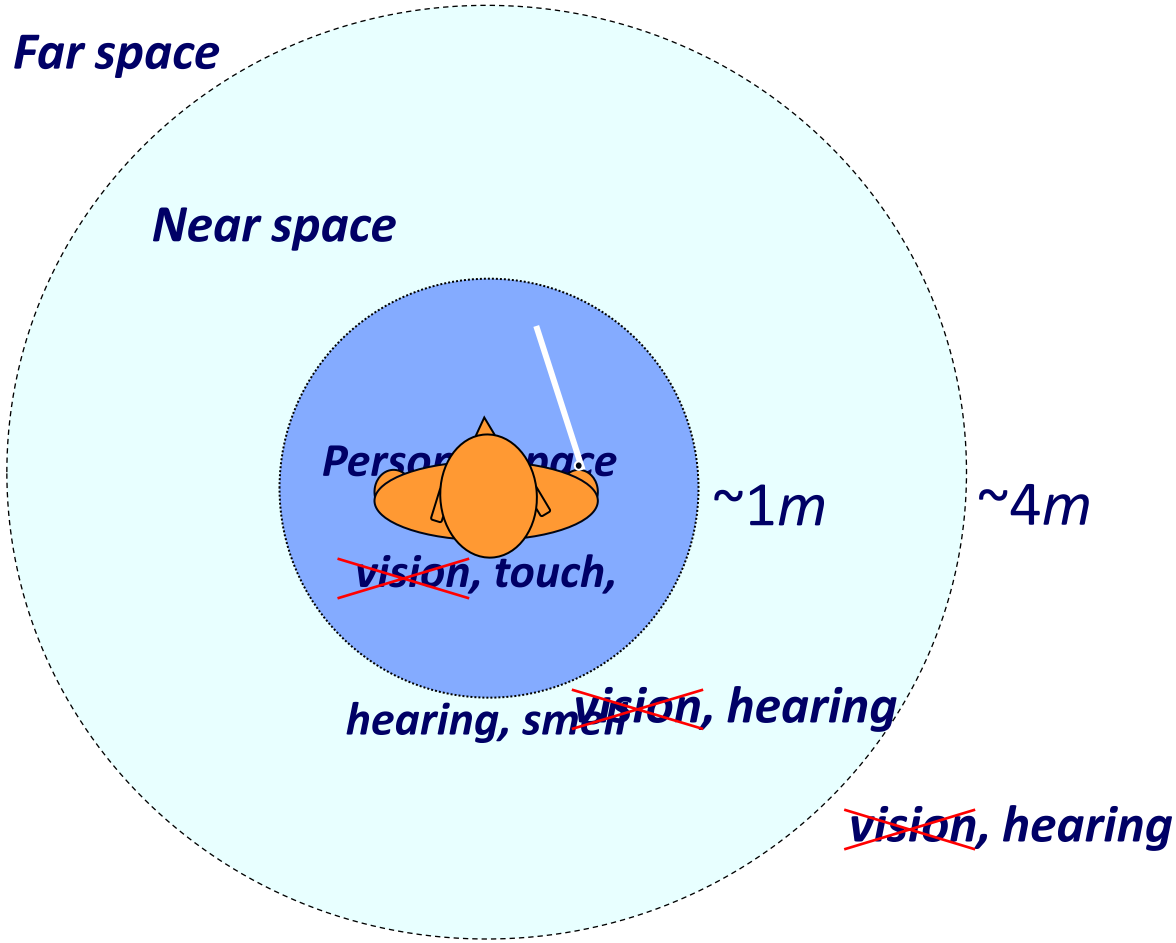
High level of concentration required



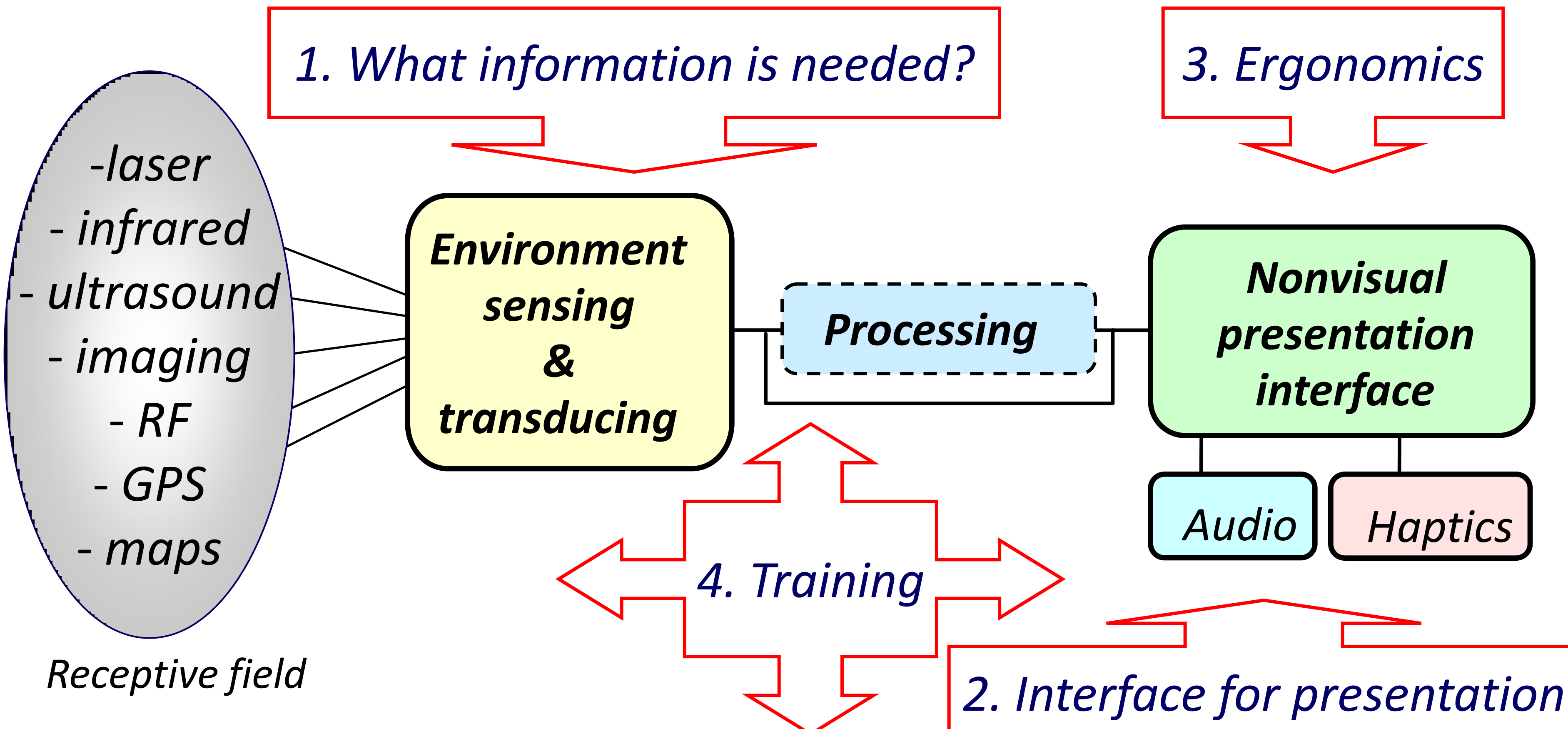
Braille Code



Hall's extra-personal space



Electronic Travel Aids (ETA)



Electronic Travel Aids (ETA)

1. *What information is needed for the blind person?*
   – *non-cluttered but not omitting important information*
2. *Interface for nonvisual presentation*
   – *not masking other sounds, intuitive (less attention)*
3. *Ergonomics*
   – *size, weight, look*
4. *Training*
   – *important for efficient use*

Design for all?

Kazimierz Noiszewski (1859–1930)

- *professor of ophthalmology deviced an original method for cornea transplantation (1921)*
- *constructed **electroftalm** (an artificial eye), a device converting light energy into auditory or tactile stimuli (**1889**)*

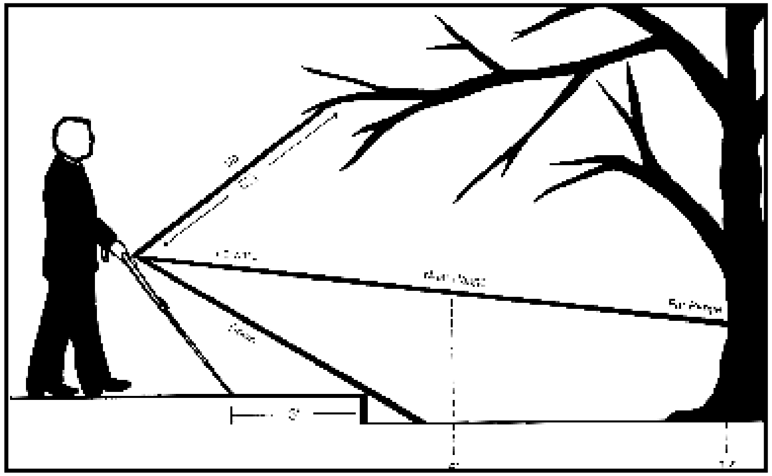
Ophthalmology Clinic Warsaw Medical Academy

Electronic mobility aids (I)

„Extension of cane functions":

- *simple construction,*
- *limited (point like) field of detecting obstacles*

LaserCane, UltraCane, SonarCane, Teletact



Electronic mobility aids (II)

Environmental imagers:

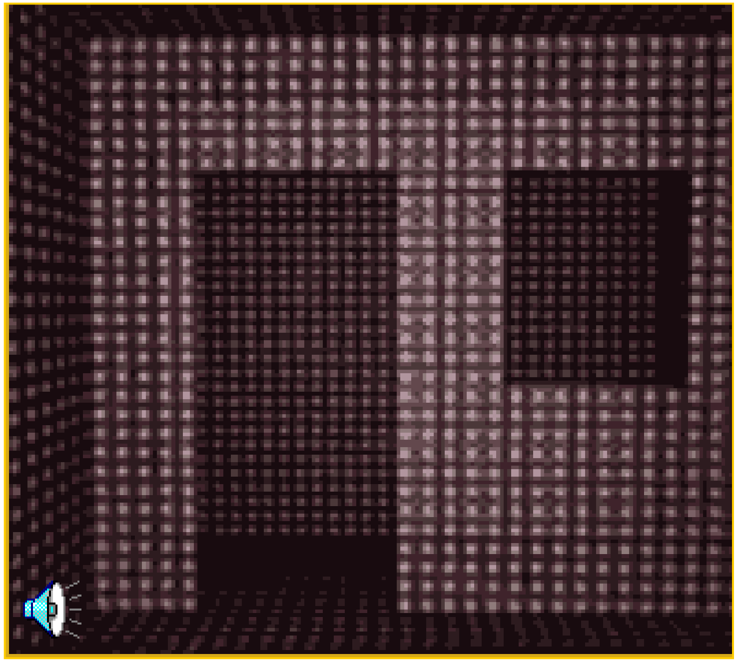
- *complex*
- *expensive*
- *information overflow*

The Forehead Retina

SonicGuide, vOICe, Navbelt, Virtual Acoustic Environment

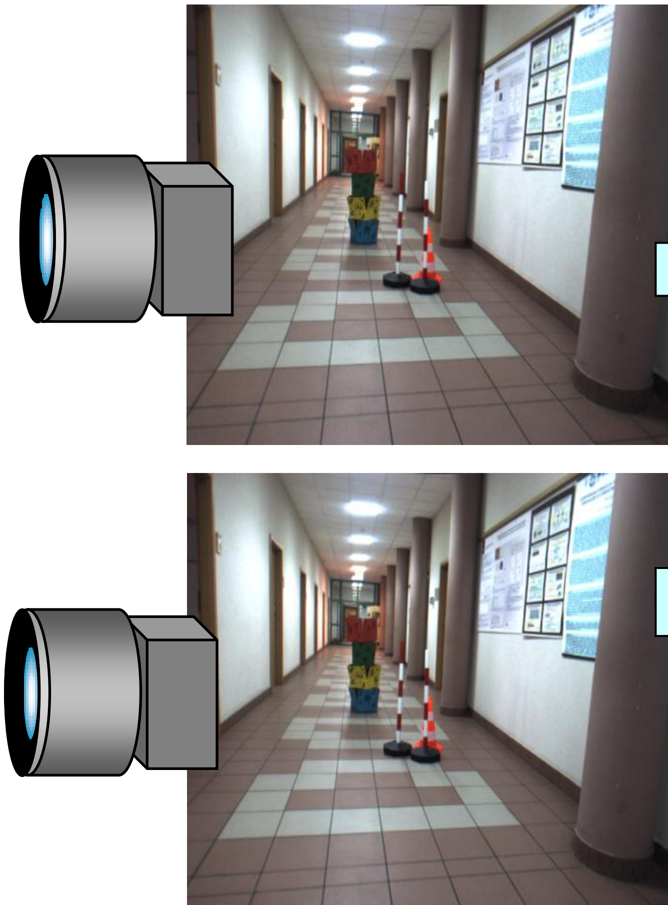
Espacio acustico virtual

Universitat de la Laguna - Tenerife

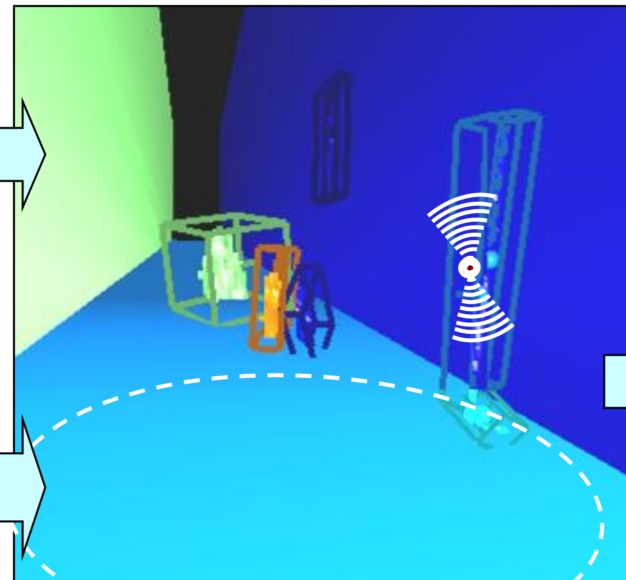


Each point is the source of a virtual sound

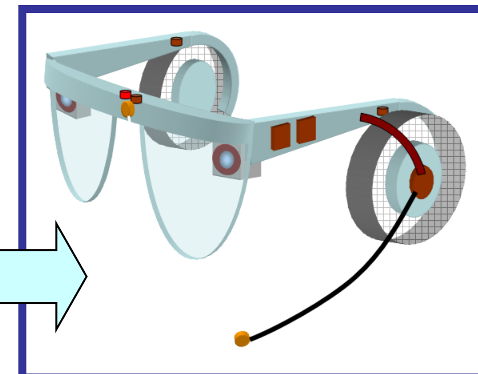
Auditory scene display



Stereovision

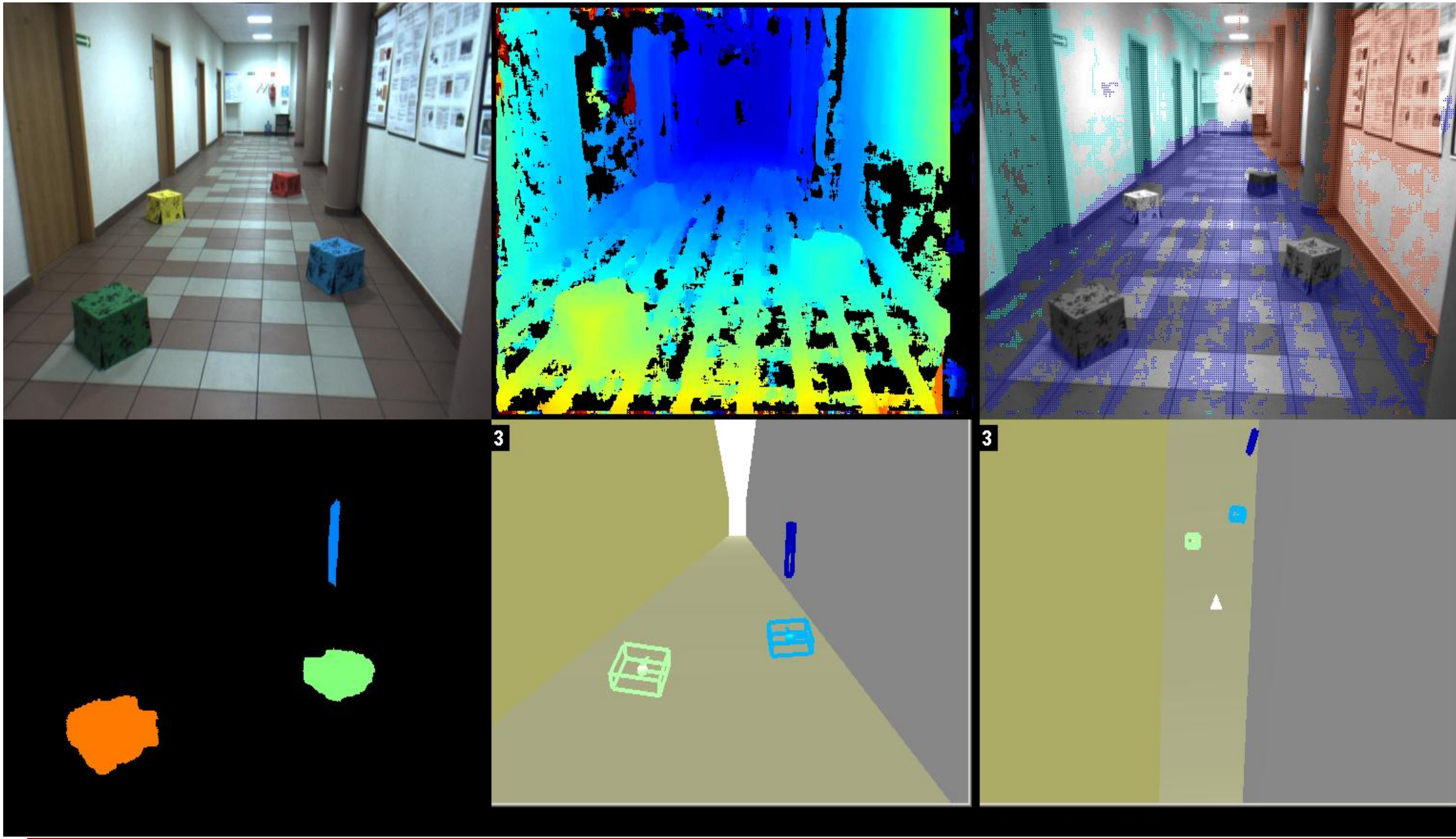


Segmented 3D scene

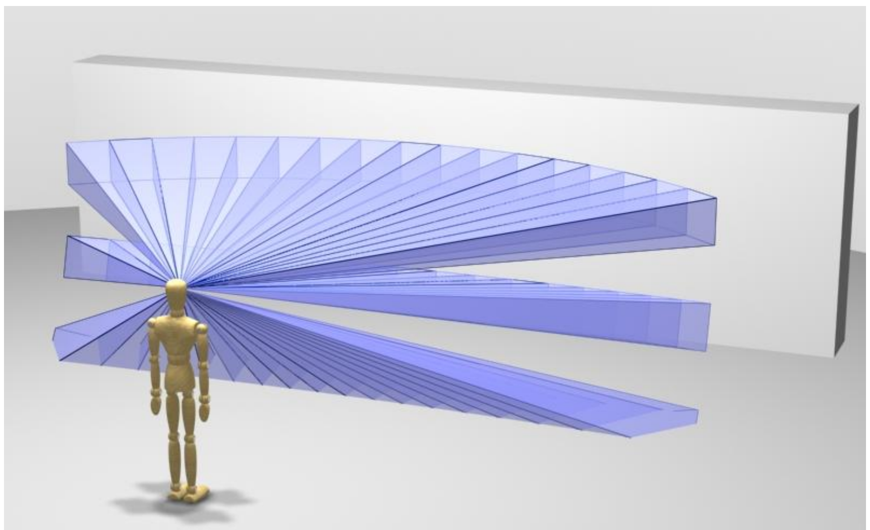


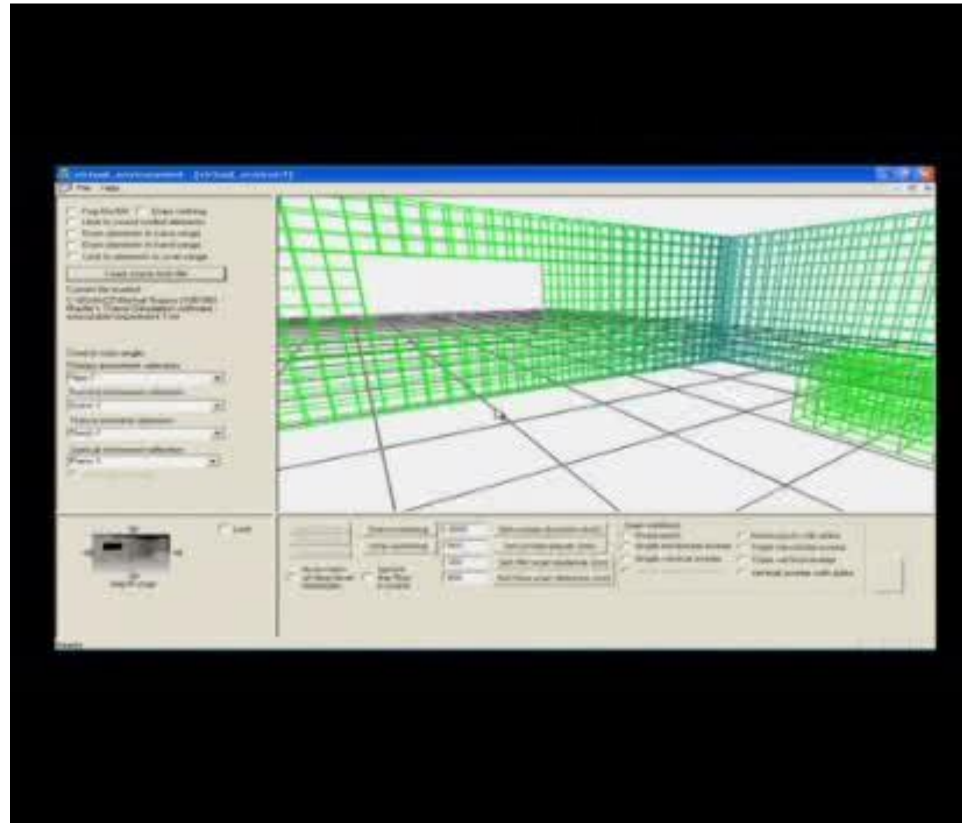
3D audio

Real scene → scene model → obstacles



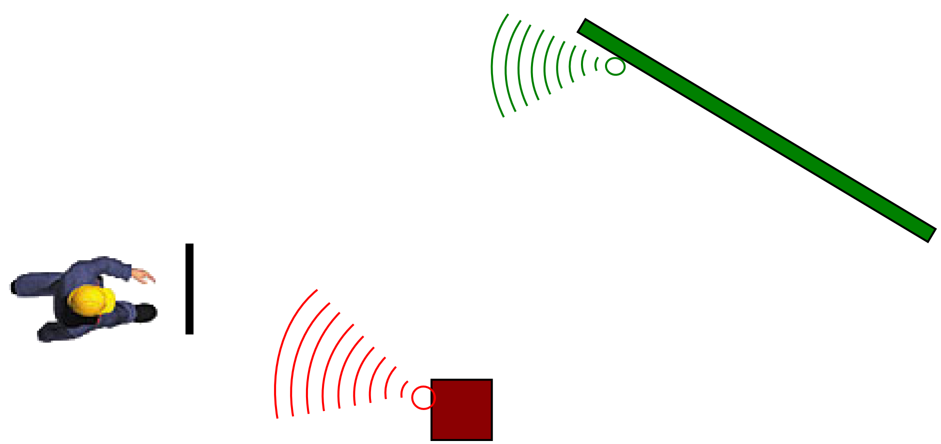
Auditory display concepts

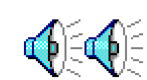




Depth scanning

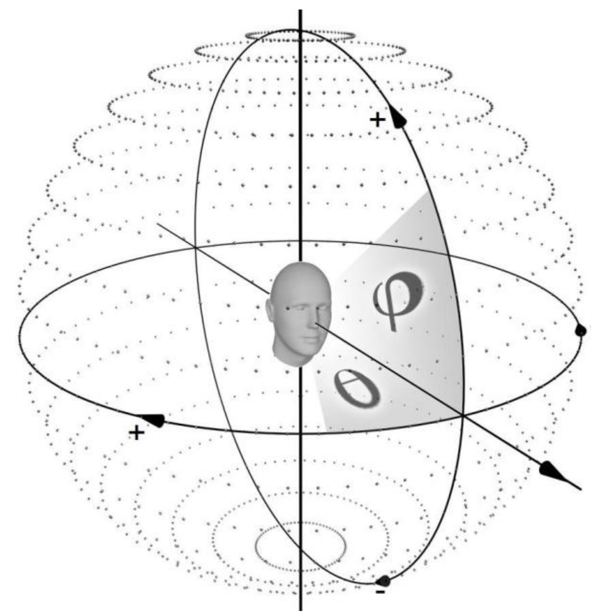
- *Inspired by sonar*
- *Sounds code objects' geometry and location*



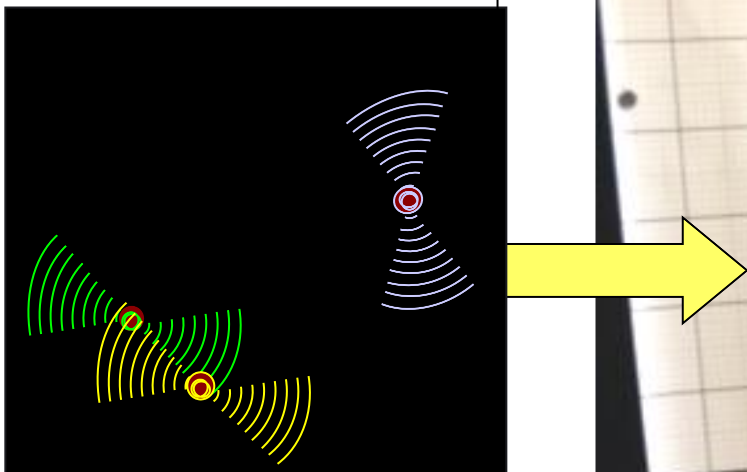


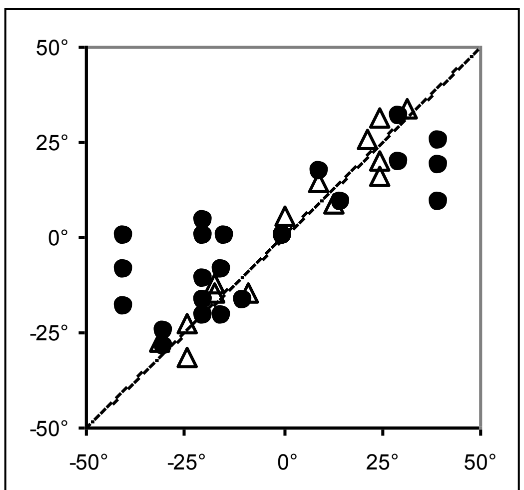
Acoustic model of the human head

Measurement of Head Related Transfer Functions (HRTF)



Spatial sound space - HRTF

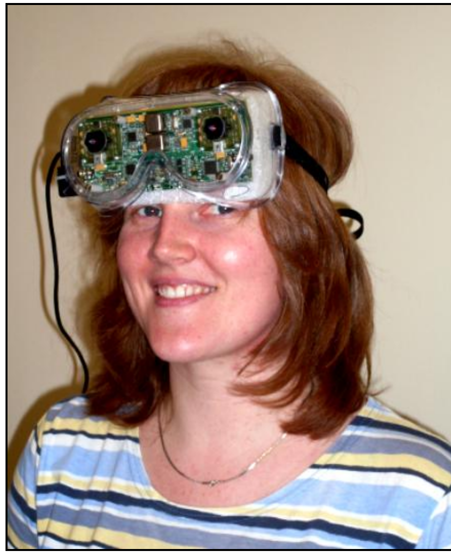




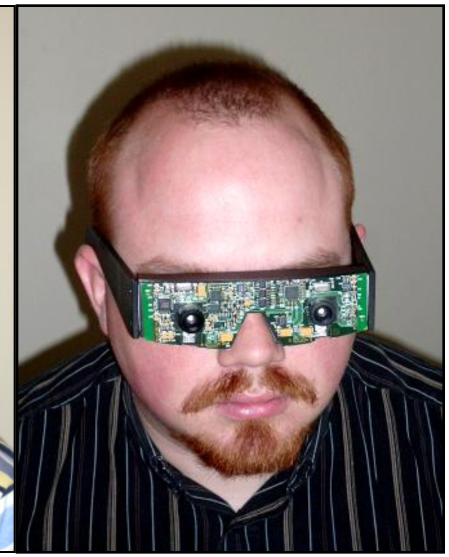
Moving sources	Real sound sources	3,1º
	Virtual sound source	8,1 º

System hardware

2007

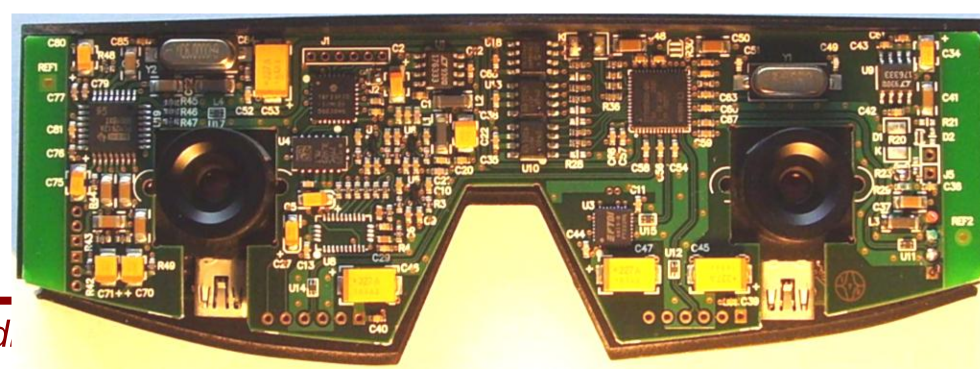


2009

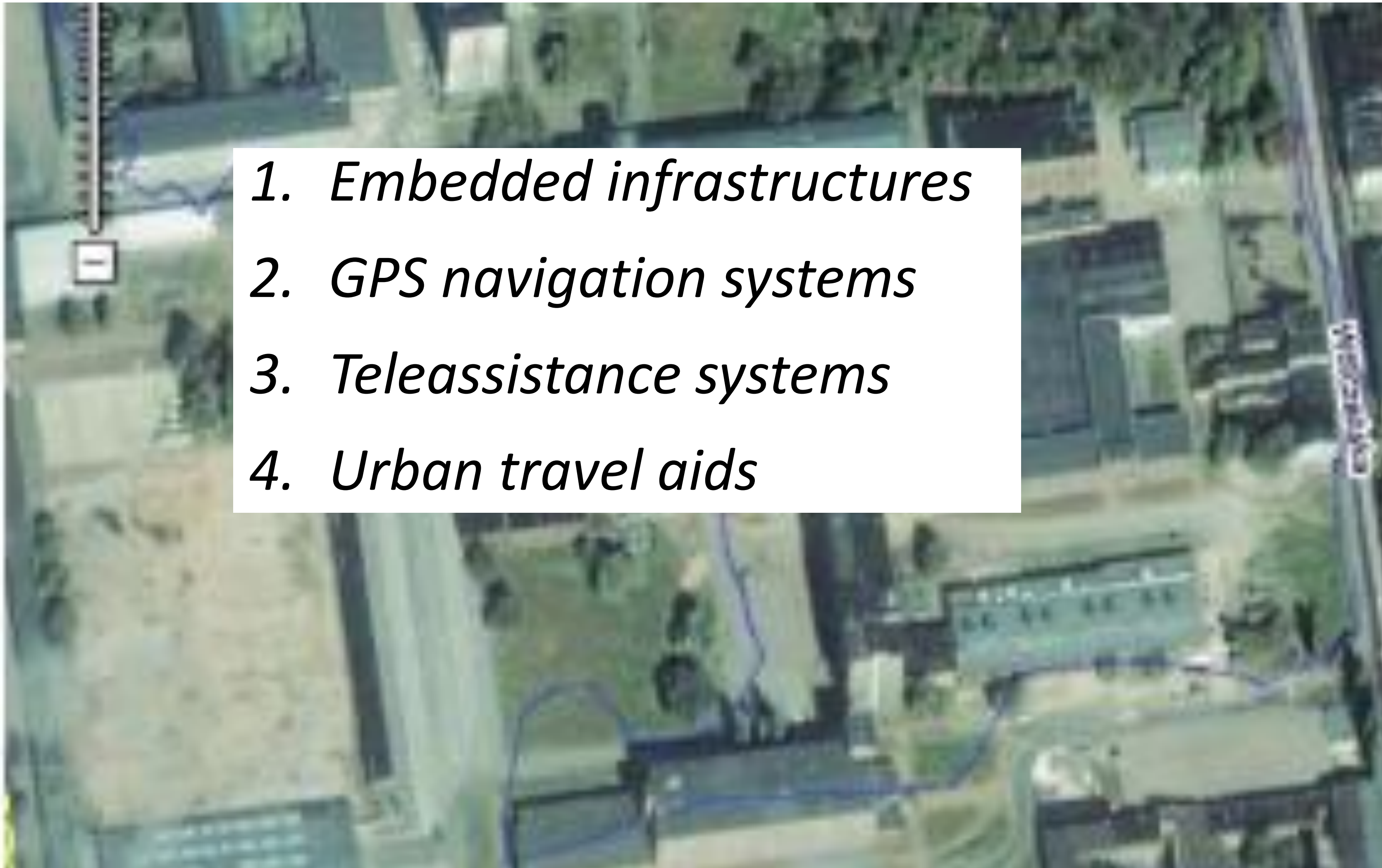


2010

20??

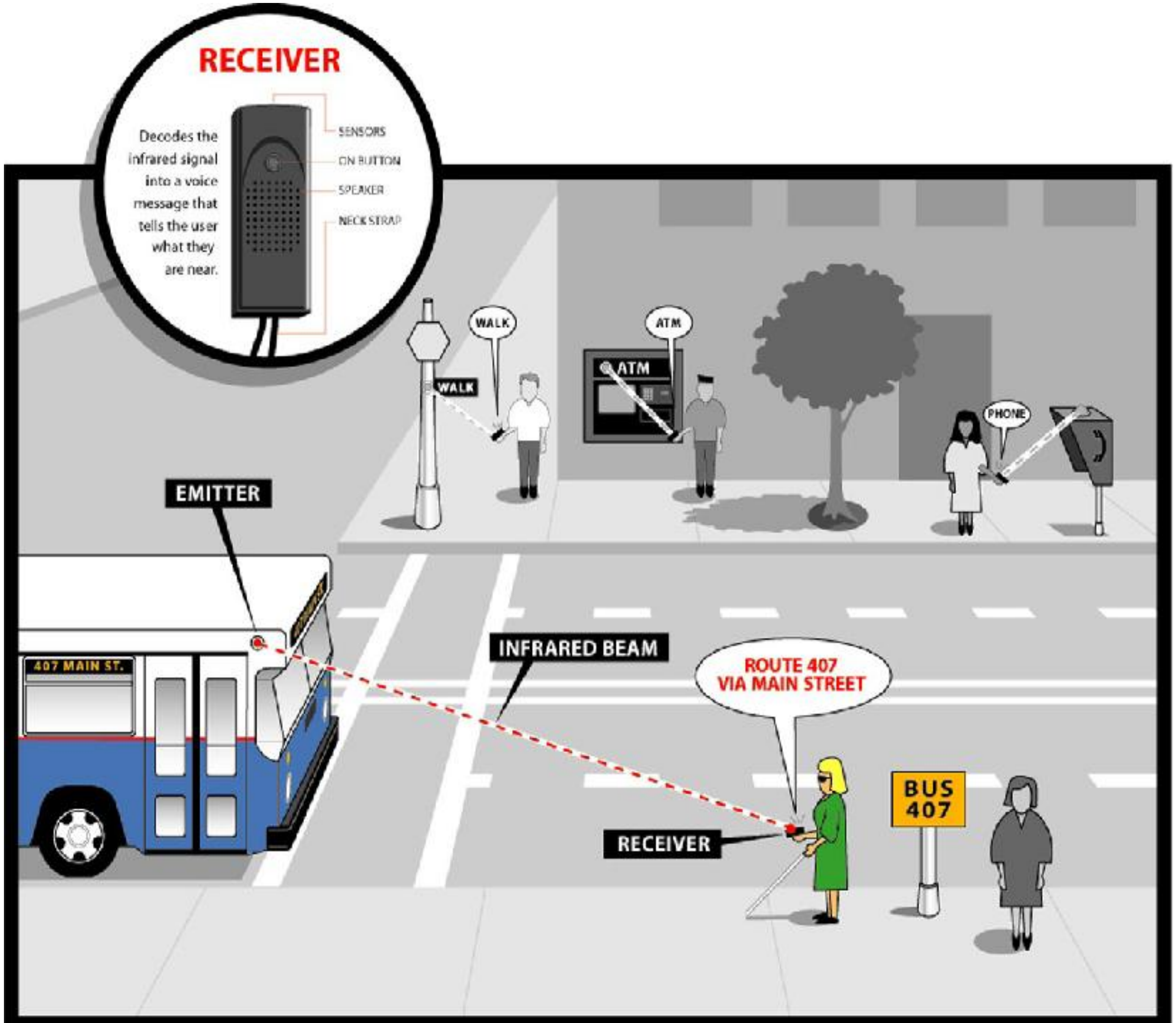


Orientation & navigation systems



1. Embedded infrastructures
2. GPS navigation systems
3. Teleassistance systems
4. Urban travel aids

Embedded infrastructures



TalkingSigns - USA

GPS-based systems

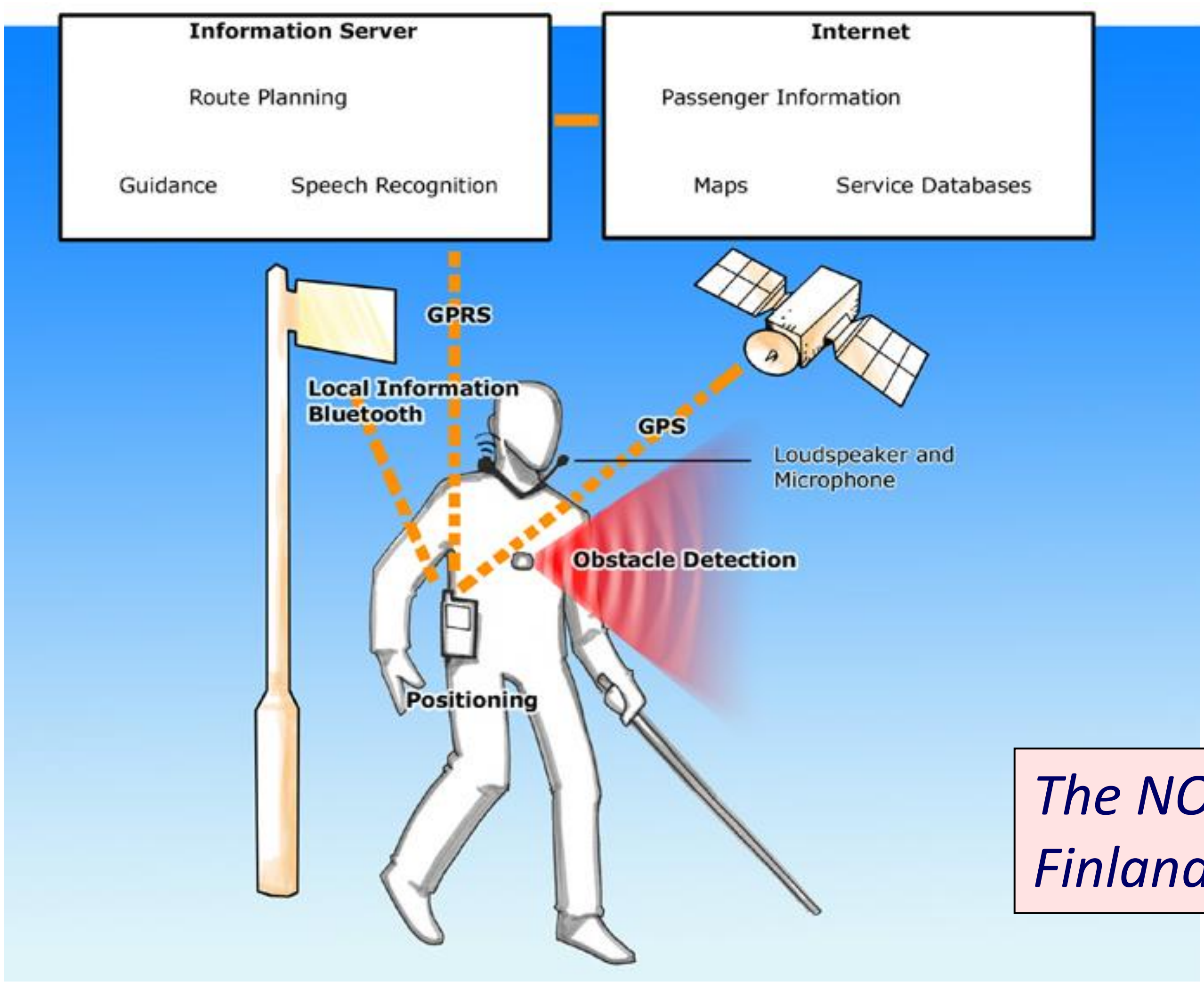
BrailleNote

EasyWalk

Trekker

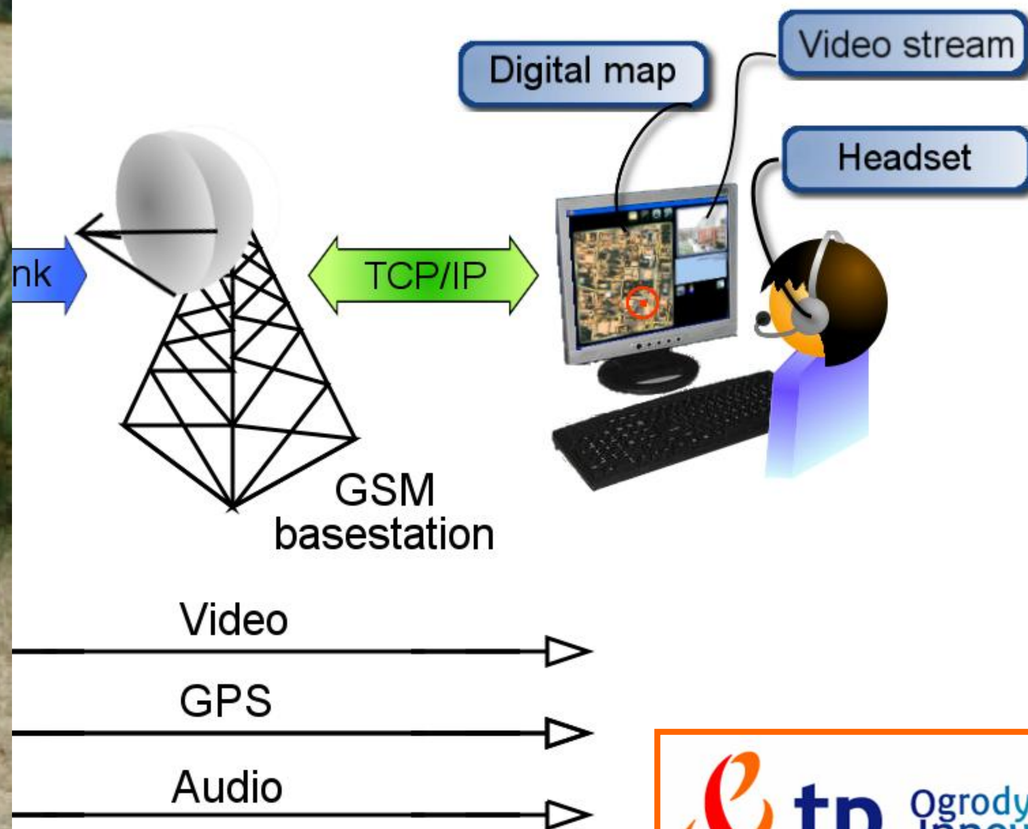
Nawigator

Urban travel aids



The NOPPA system - Finland

Teleassistance systems



System trials

Operator's terminal


RemoteAssistant
InfoBoard
Client connected from 83.220.111.70:1134
Received JPEG stream
Received JPEG stream
Client disconnected from 83.220.111.70:1134
Client connected from 83.220.111.70:1150
83.220.111.70
0
1
5
10
Uplink
Downlink
15.35MB
15.73MB
5.33MB
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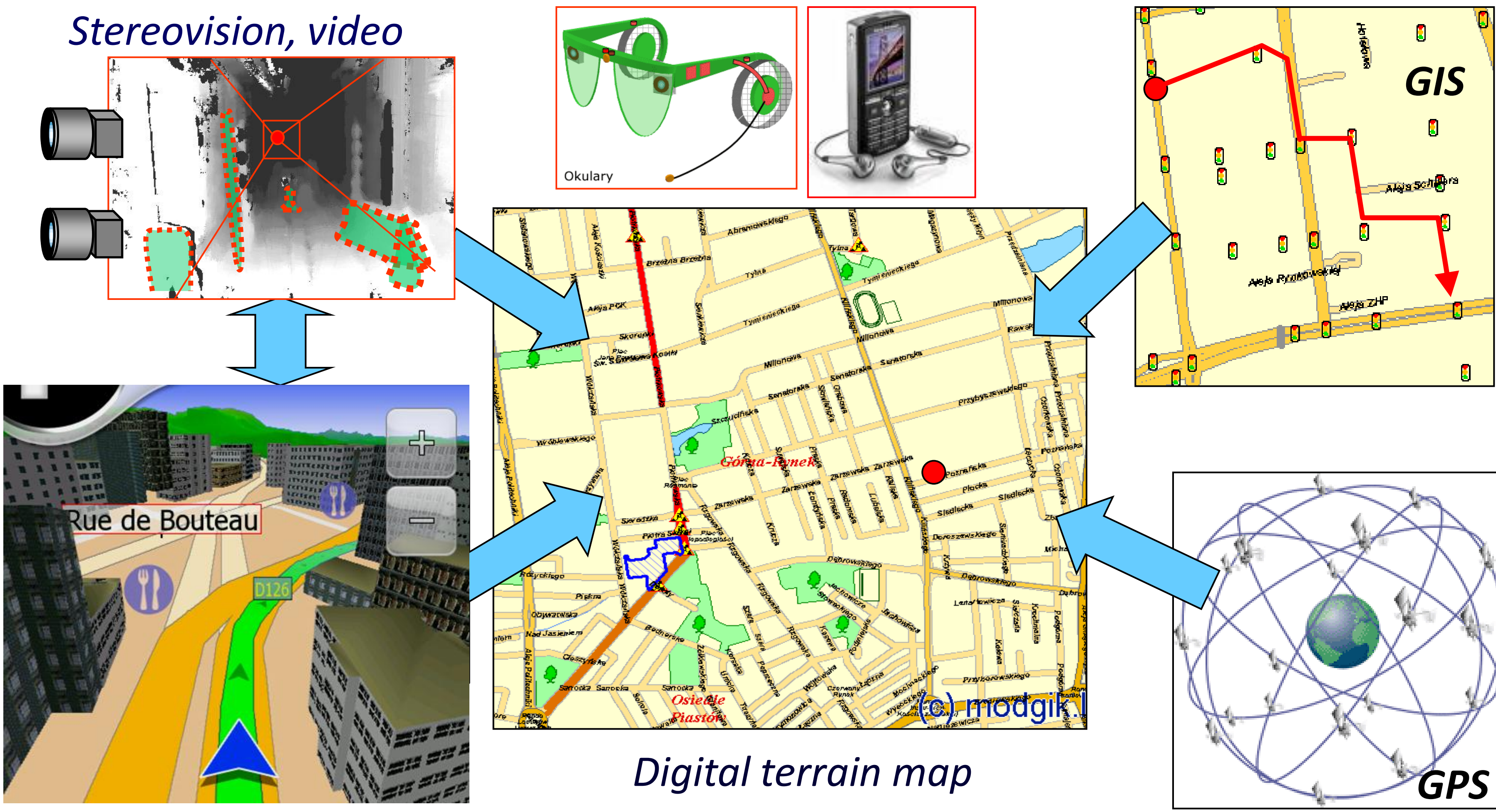
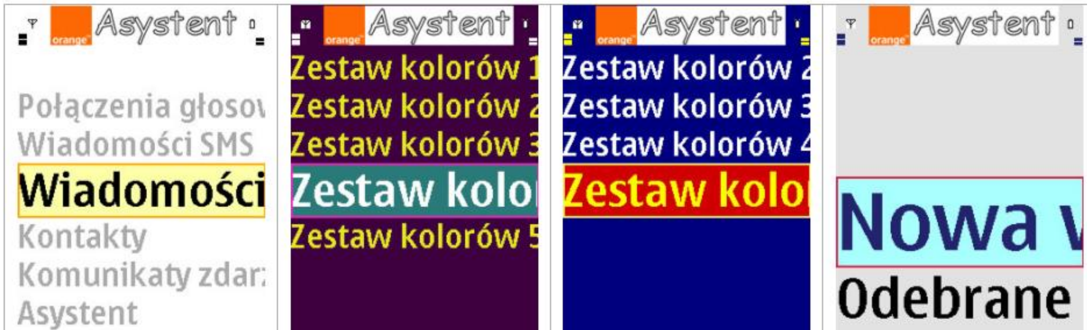
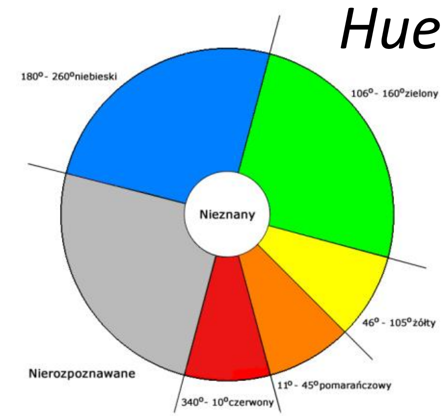
Remote navigation system (v.3)

Integration of functions



Smartphone for the visually impaired





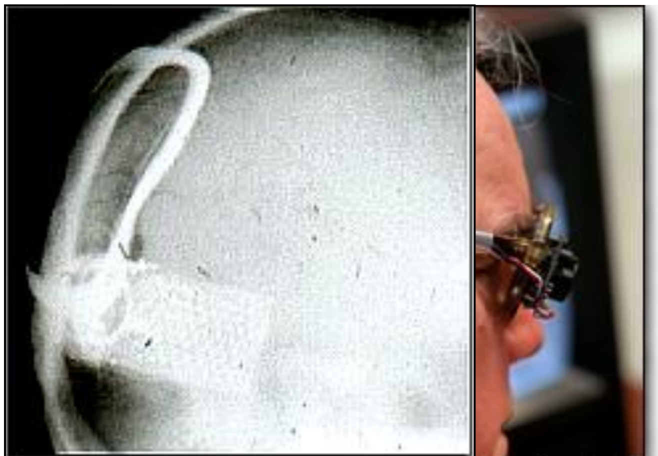
symbian Developer Network

Symbian smartphone assisting the blind:

- *phone functions*
- *speech synthesis*
- *GPS navigation*
- *colour recognition*

Reading signs

Visual prothesis



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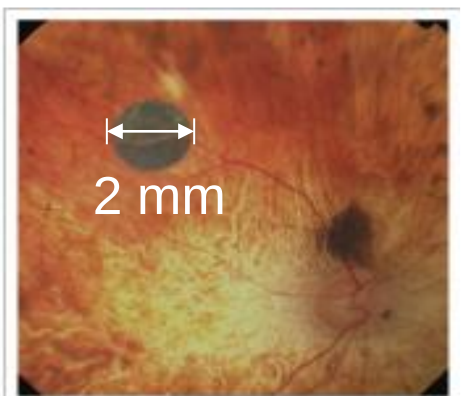
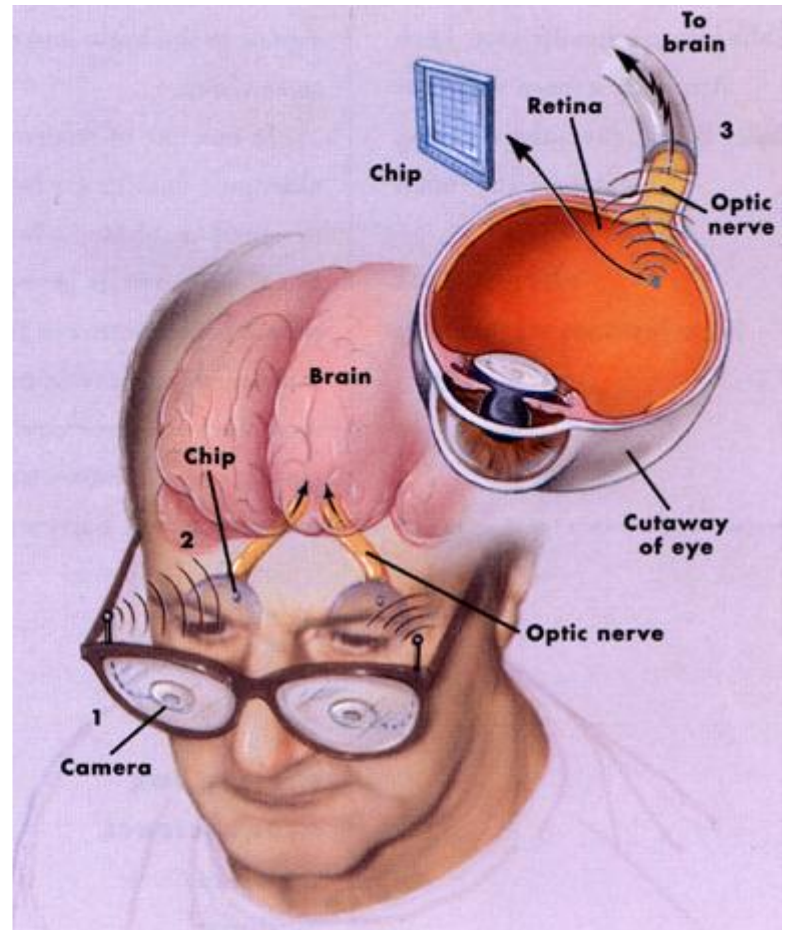


ASR® device implanted in the human eye



Concluding remark

Instead of asking:

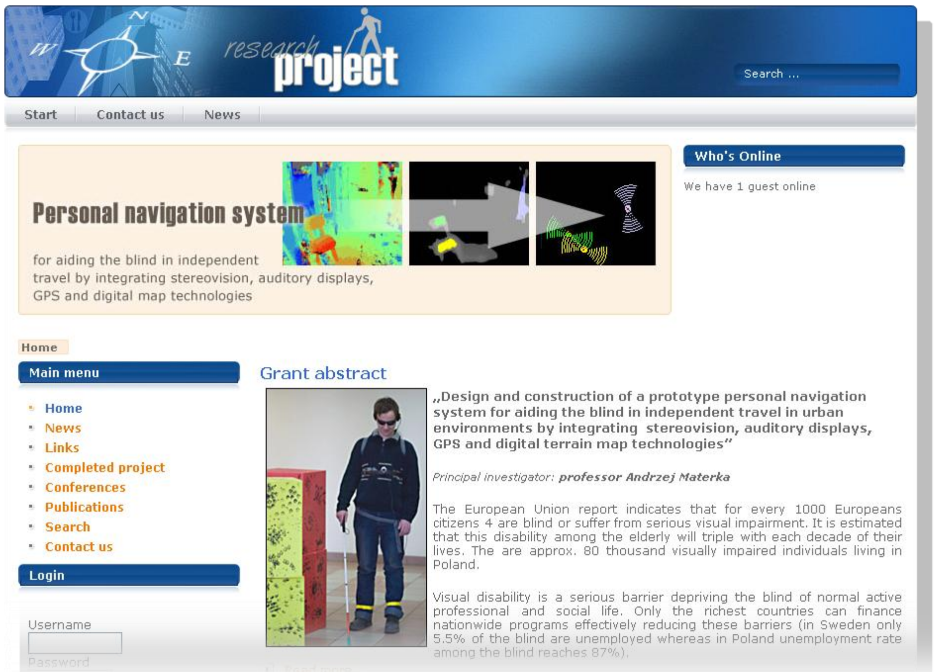
“How can this technology be adapted to the blind user?”

we want to ask:

“What information is actually needed by a visually impaired traveller and how it should be presented to him/her?”.

Smith-Kettlewell Eye Research Institute

Acknowledgements



www.naviton.pl

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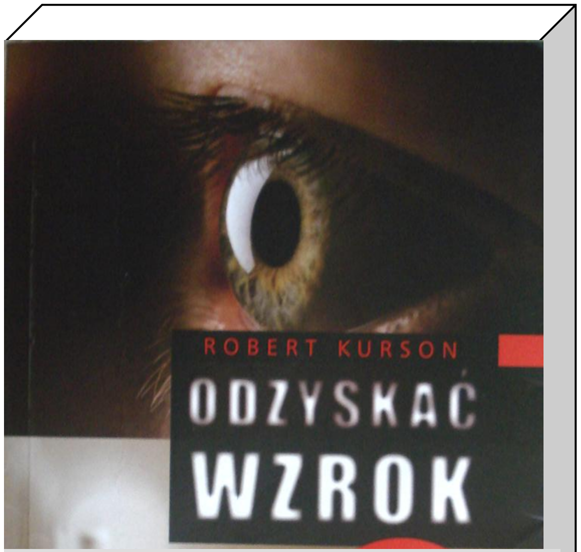
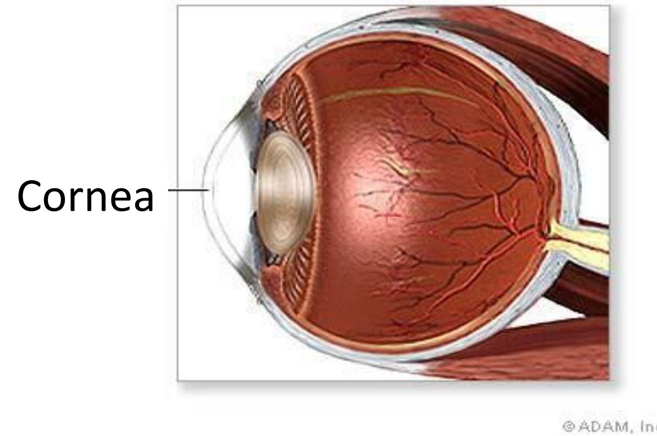
Long-term vision loss



R. Kurson, „*Crashing through: a true story of risk, adventure and the man who dared to see*”, Random House Inc., 2007



***The blind who recovered sight*:**

- *recognise: motion and colours*
- *do not recognise: shapes, faces, objects*
- *false depth perception*

Cause:

plasticity of nerve cells

Outlook