

Politechnika Łódzka

Instytut Elektroniki

How to show the world to the blind?

Paweł Strumiłło

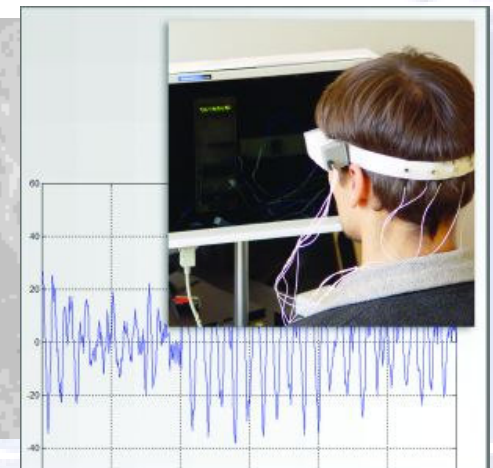
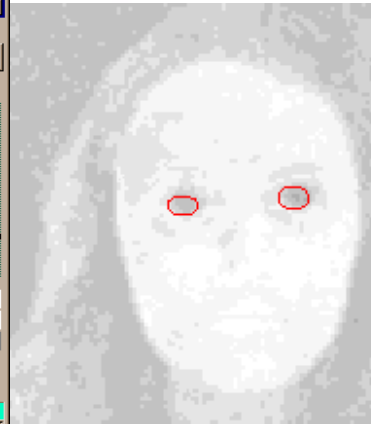
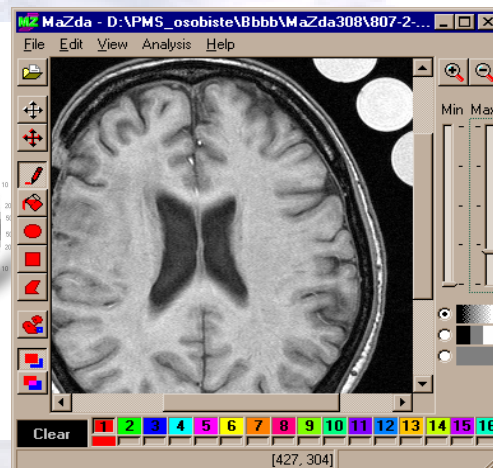
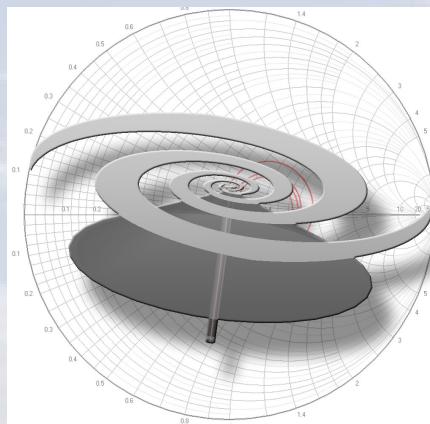
Zakład Elektroniki Medycznej





Institute of Electronics

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





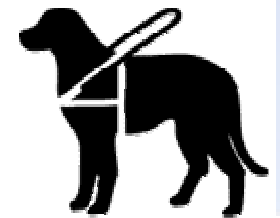
www.
niepełni  sprawni
PORTAL DLA OSÓB NIEPEŁNOSPRAWNYCH .pl

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 \$**





Day-to-day problems of the blind

I. Safety and independent travel

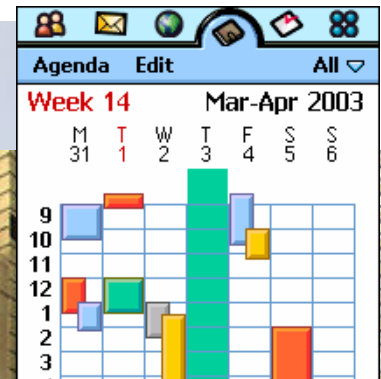
- *avoiding obstacles and pedestrians*
- *detection of surface discontinuities (stairs, curbs...*
- *avoiding collisions with vehicles*
- *avoiding robbery and thefts, ...*

II. Navigation

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

III. Access to information

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





Sensory substitution

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

Braille Code

A	B	C	D	E	F	G	H	I	J
⠠	⠠	⠠	⠠	⠠	⠠	⠠	⠠	⠠	⠠





Kazimierz Noiszewski (1859–1930)

- ❑ *professor of ophthalmology USB (1919-21) i UW (1921-29); devised an original method for cornea transplantation (1921)*
- ❑ *constructed **electroftalm** (an artificial eye), a device converting light energy into auditory or tactile stimuli (**1889**)*

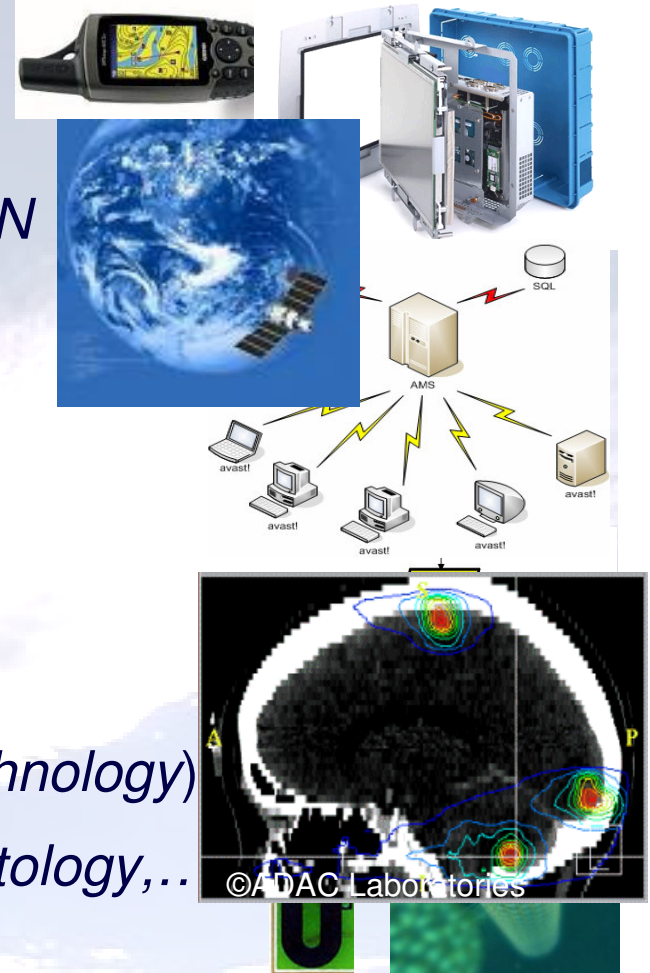
***Ophthalmology Clinic
Warsaw Medical Academy***





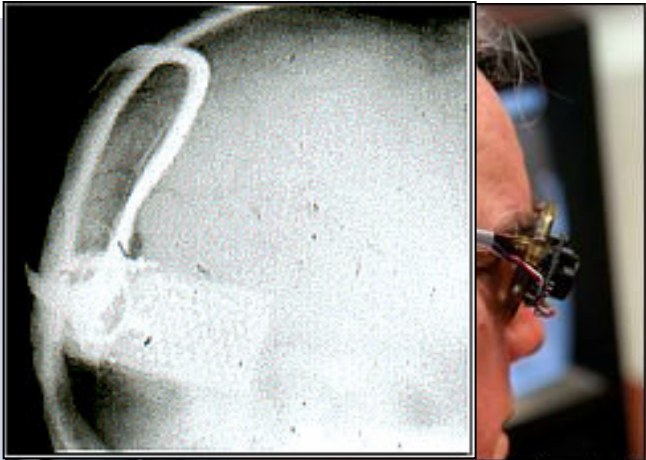
Technology of the XXI century

- ❑ *small and fast computing devices (minicomputers, notebooks, PDAs,...)*
- ❑ *telecommunication networks PAN, LAN, WAN (WiFi, internet, cellular networks 3G,...)*
- ❑ *satellite navigation systems (GPS, Galileo, Glonass, portable receivers)*
- ❑ *advanced computing algorithms and programming tools,*
- ❑ *miniaturization of electronic devices (sensors, implants, micromachines, nanotechnology)*
- ❑ *medical technologies (diagnostics, transplantology,..)*



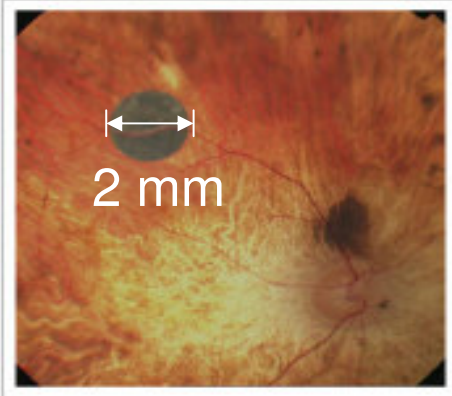


Visual prosthesis

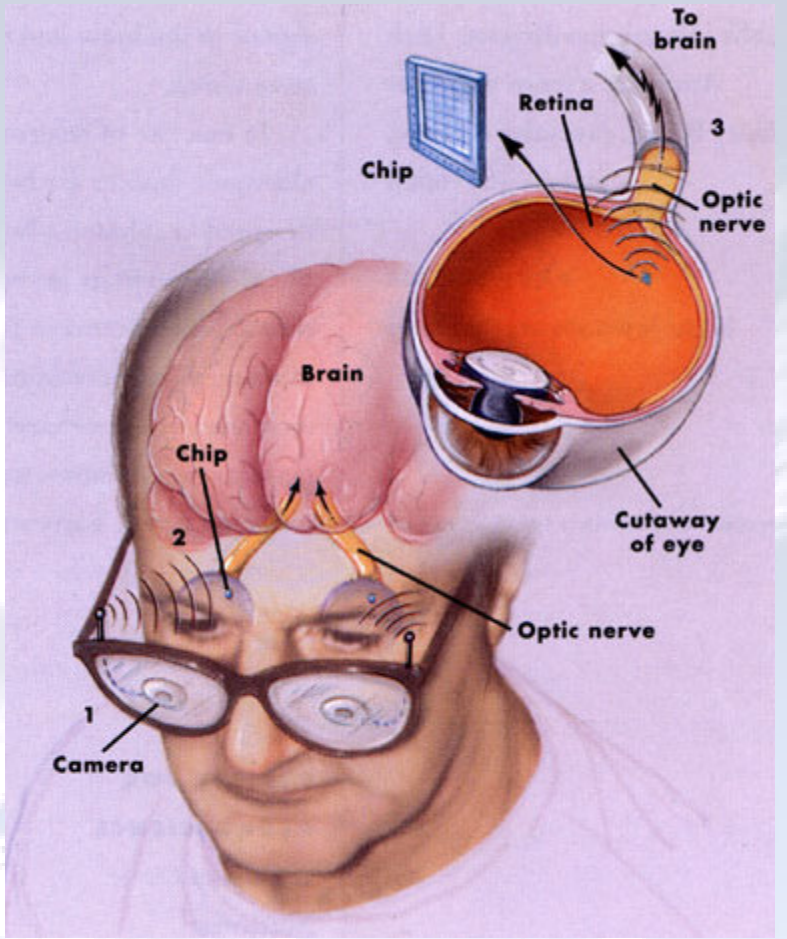


Stephen Chernin / AP

©2000 American Society of Artificial Internal Organs.

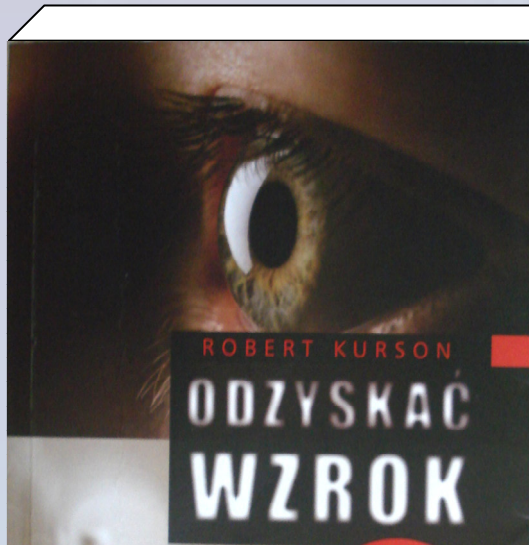


ASR® device implanted in the human eye





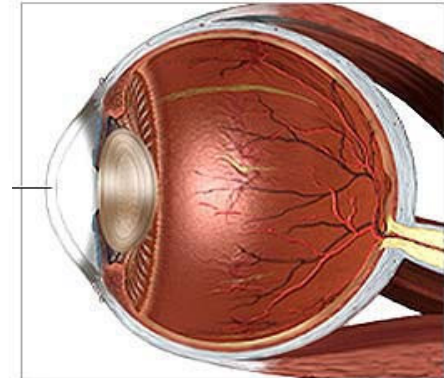
Consequences of long-term vision loss



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



Mike May



Cornea

© ADAM, Inc.

The blind who recovered sight:

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

Cause:

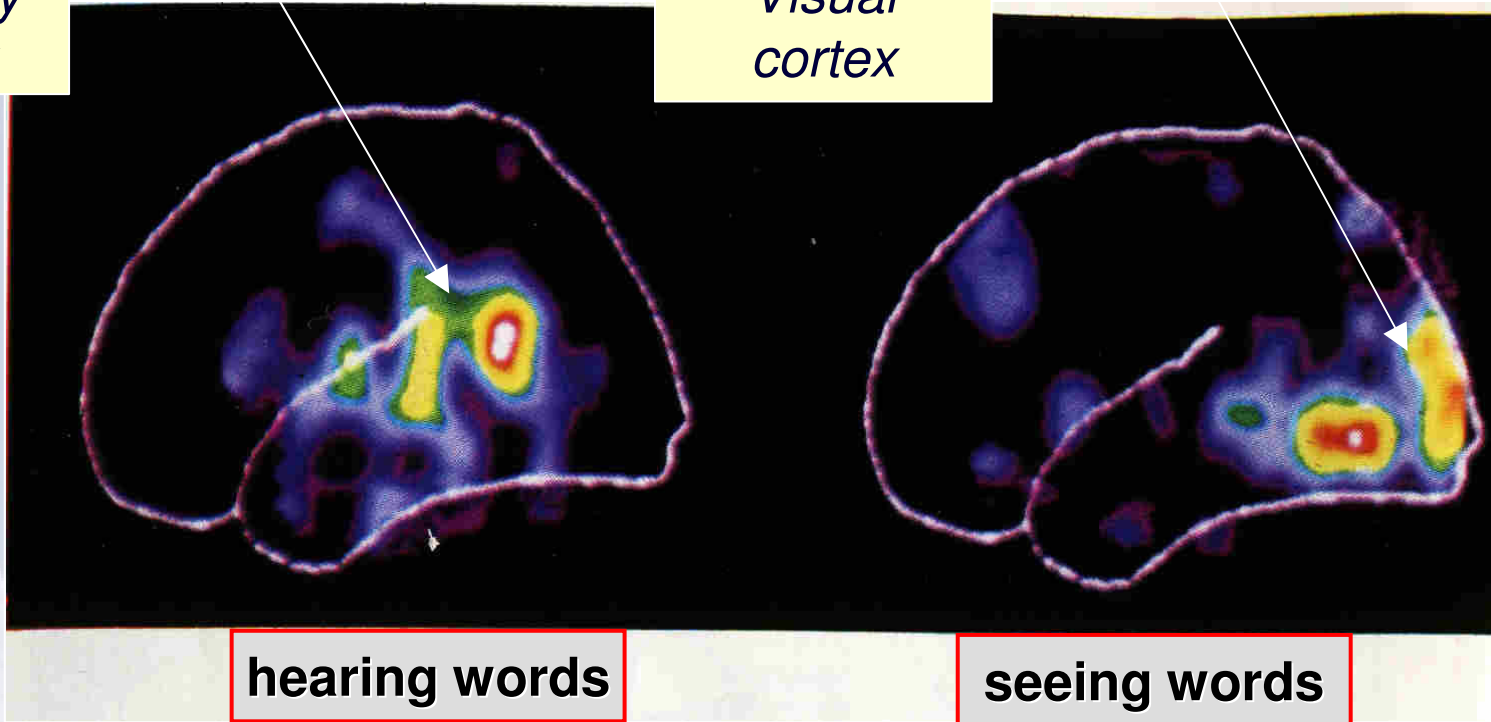
plasticity of nerve cells



Computed fMRI

Auditory
cortex

Visual
cortex



hearing words

seeing words

The sight activates approx. 70% of brain regions

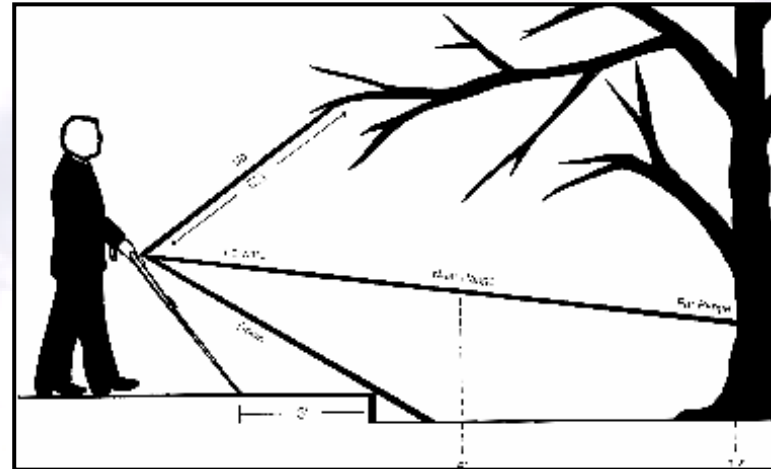


Electronic travel aids

„Extension of cane functions”:

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

LaserCane, UltraCane SonarCane





Electronic travel aids

Environmental imagers:

- complex
- expensive
- informat

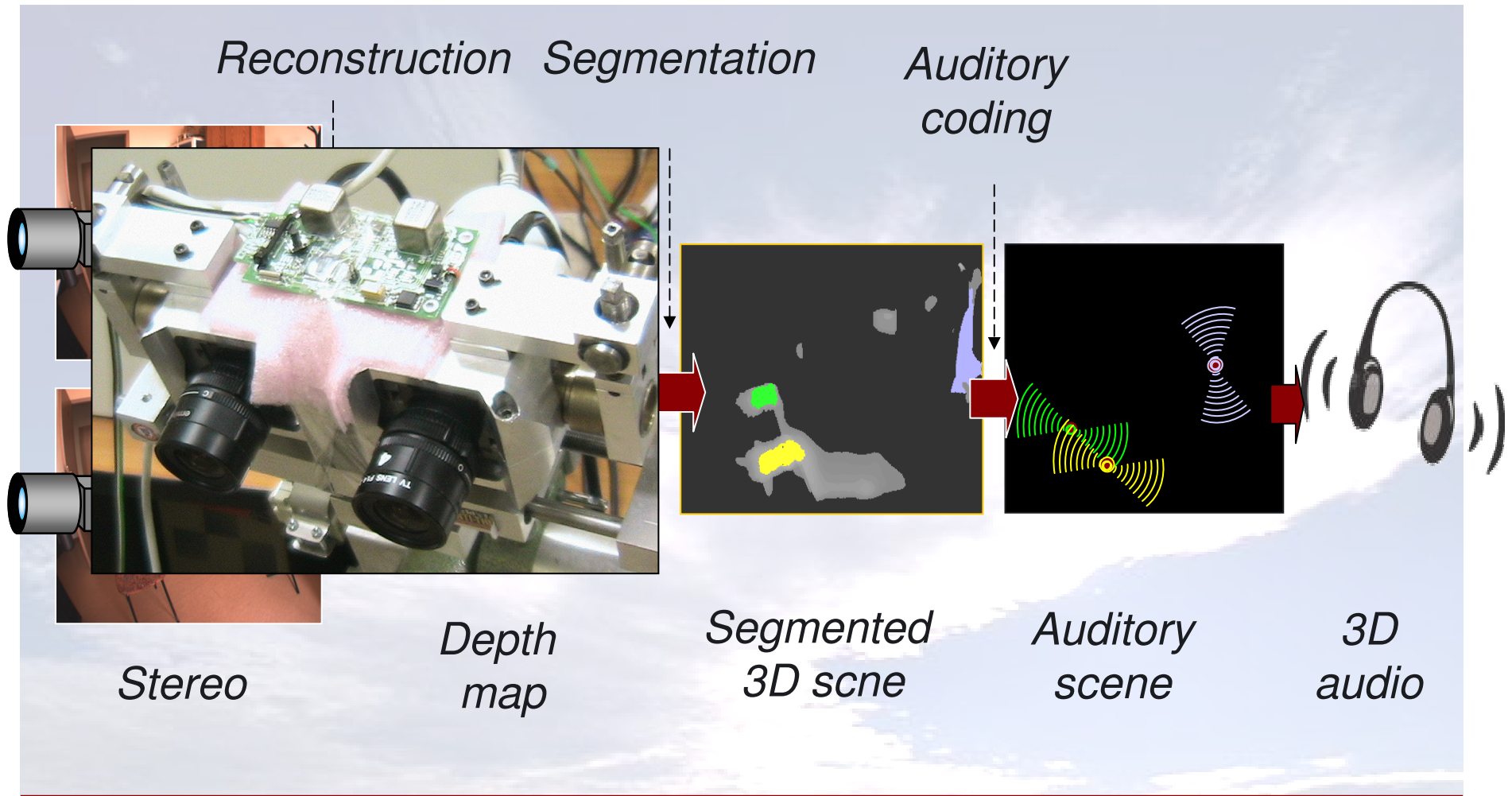
100 years after the first steps taken by Noiszewski, still no electronic travel aid has found ubiquitous acceptance by the blind!

SonicGuide, vOICe, Navbelt, Virtual Acoustic Environment



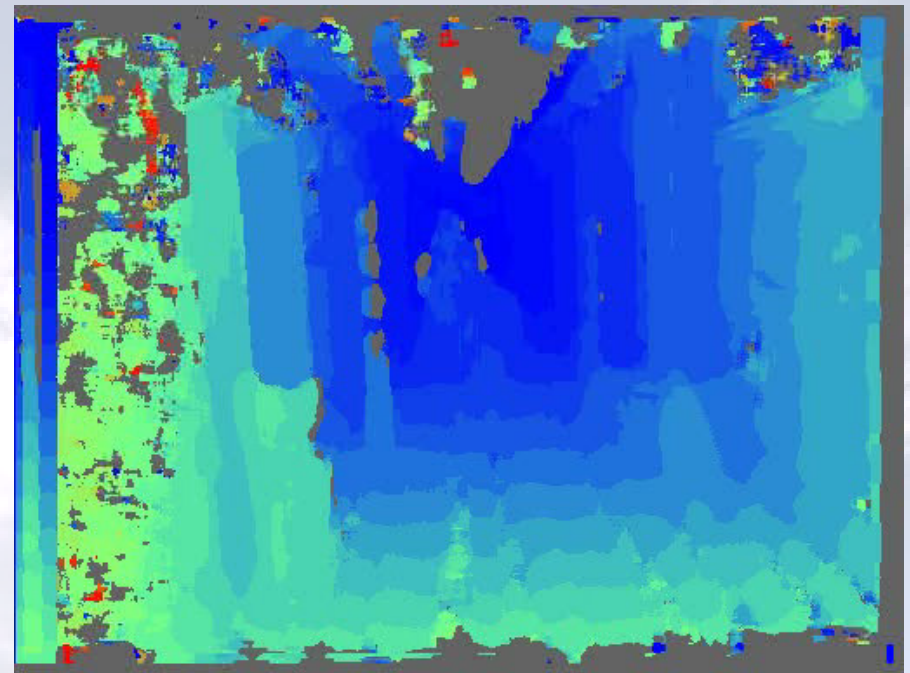


Dźwiękowe obrazowanie otoczenia



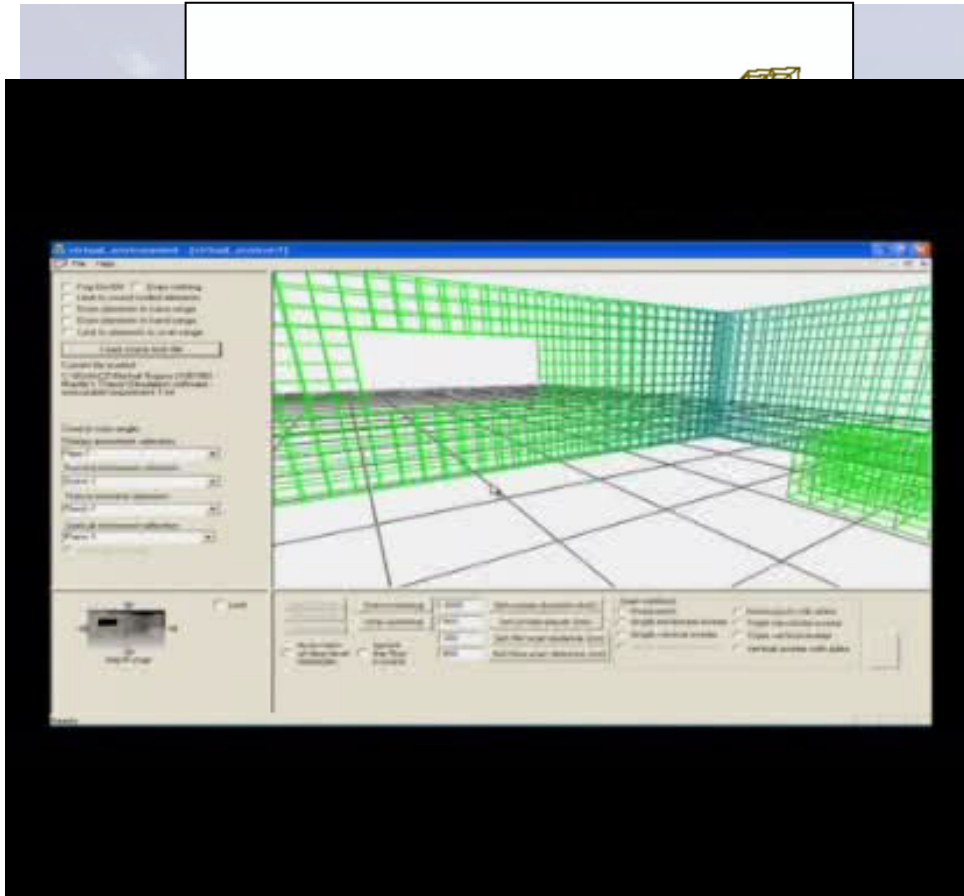


Imaging of depth





Auditory display concepts





Acoustic model of the human head



*Measurement of
Head Related
Transfer Functions
(HRTF)*



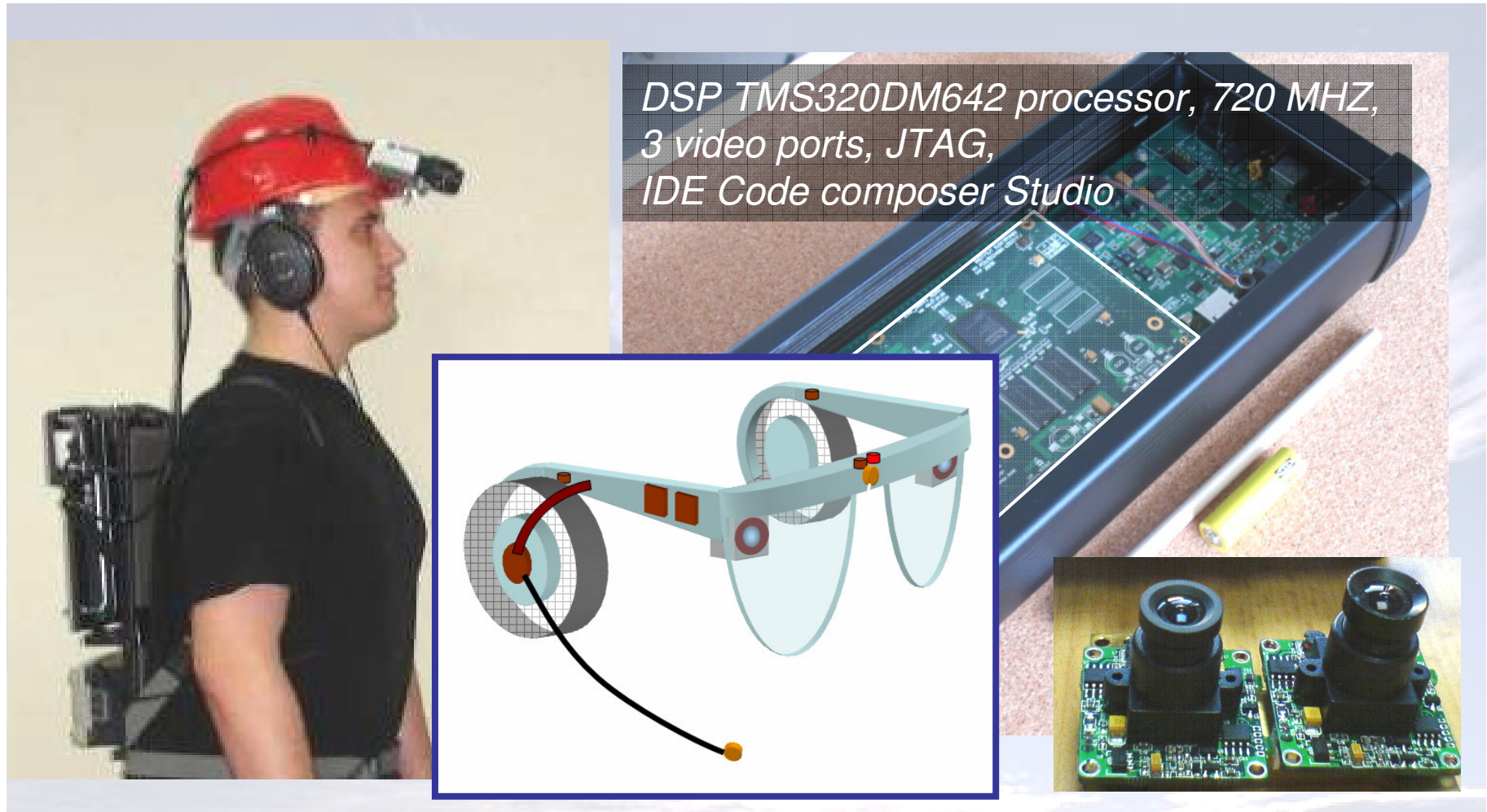
Spatial sound

The diagram on the left illustrates sound wave propagation from two moving sources (red and yellow dots) and a stationary source (red dot). The grid on the right shows a person wearing headphones pointing at a specific location on the grid, likely representing a virtual sound source.

<i>Moving sources</i>	<i>Real sound sources</i>	<i>3,1°</i>
	<i>Virtual sound source</i>	<i>8,1°</i>

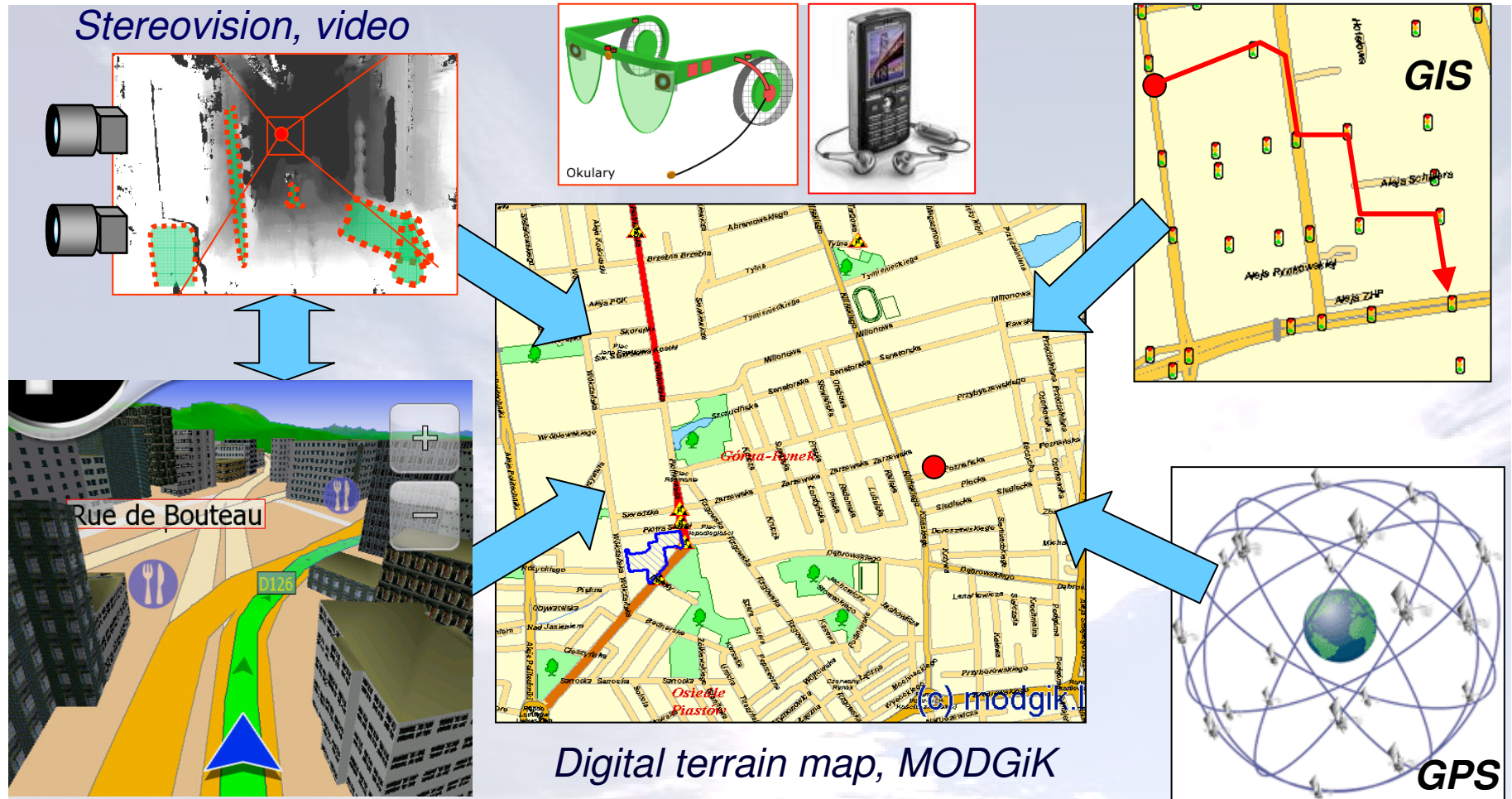


System hardware



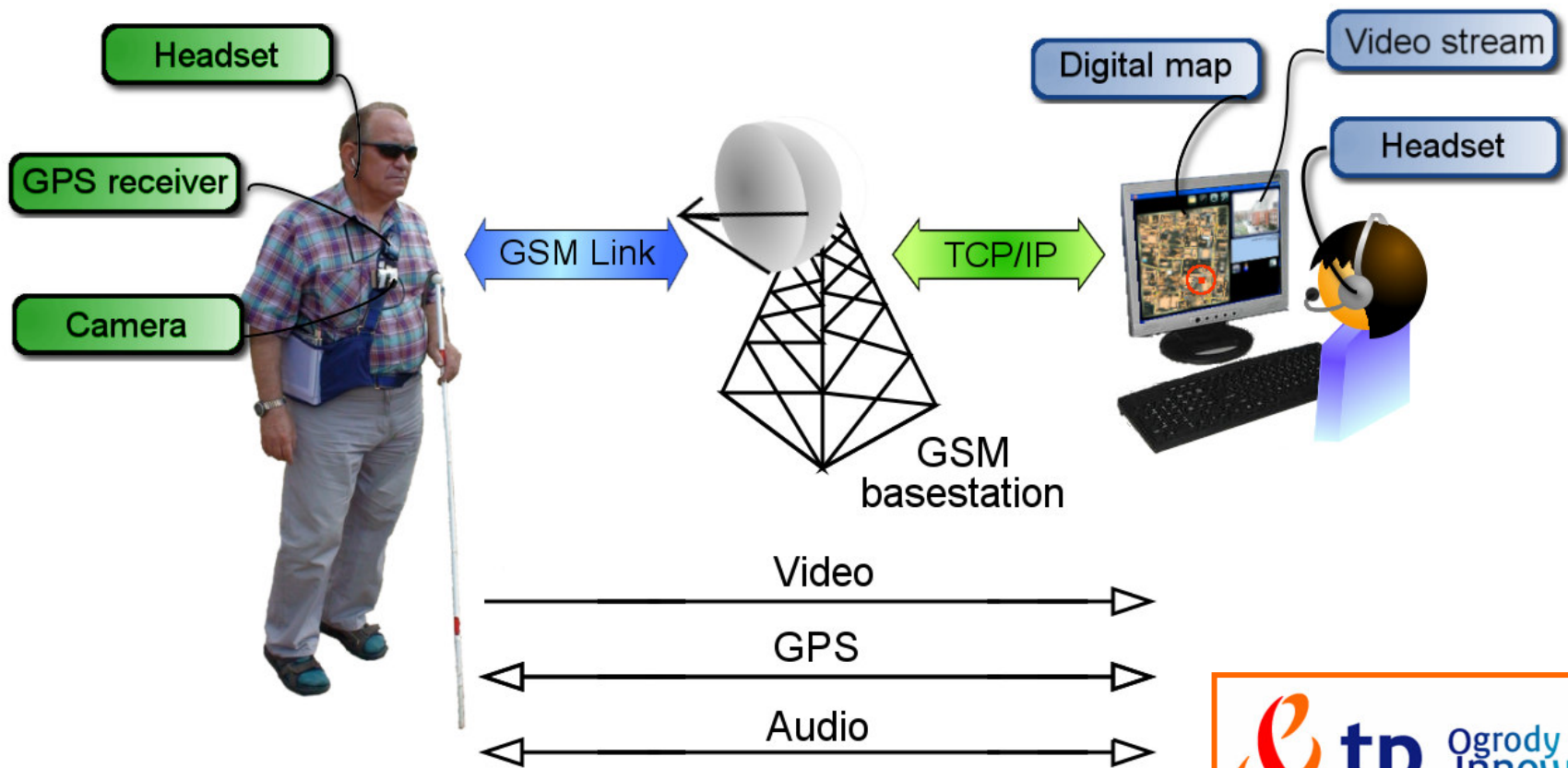


Navigating the blind



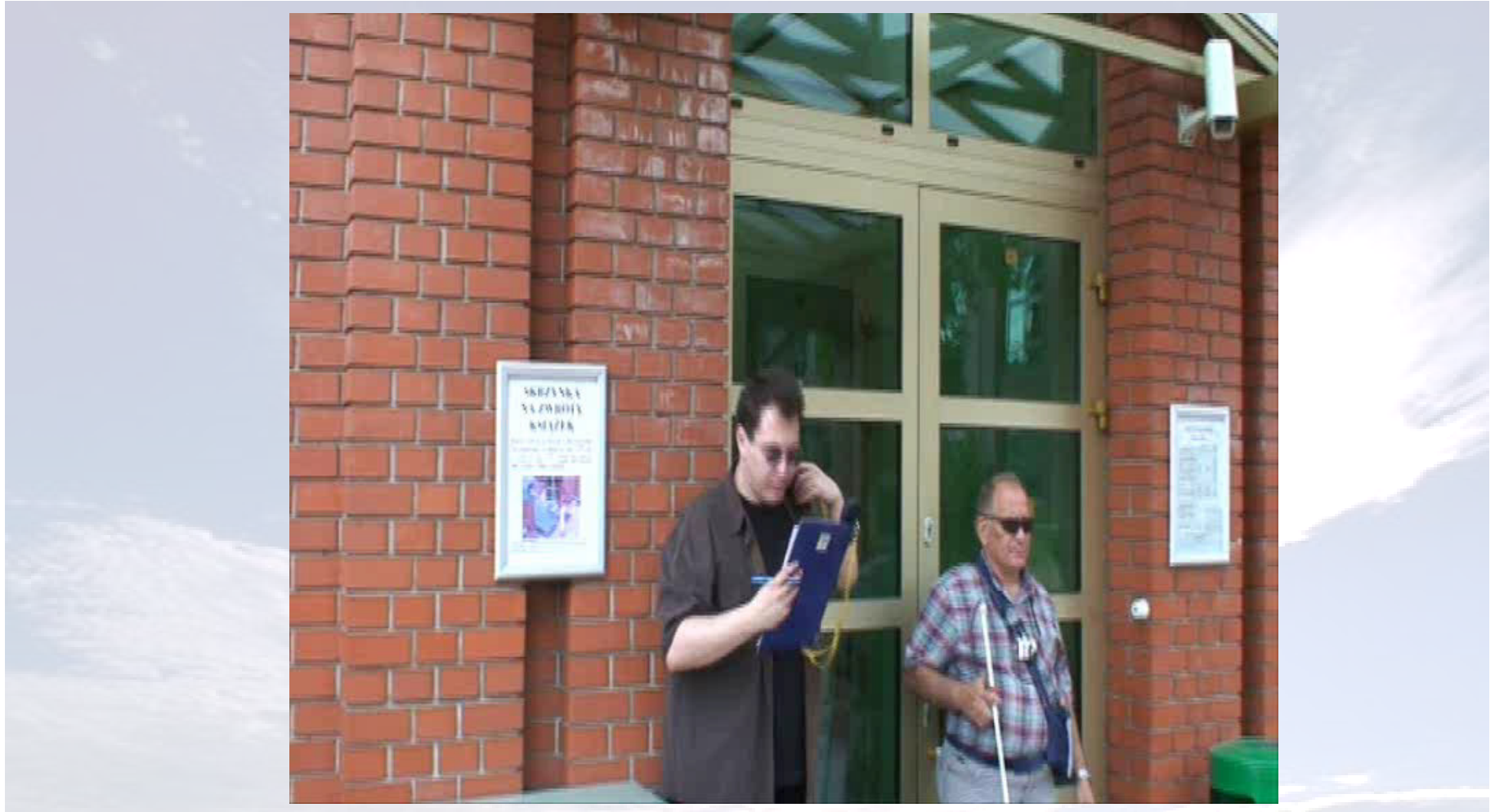


Remote navigation system





System trial





Operator's terminal

RemoteAssistant

video images from the blind user's camera

digital map with the position of the blind user

high resolution screenshot for text

83.220.111.70

90

Uplink

1.98MB 1.88MB 1.06MB

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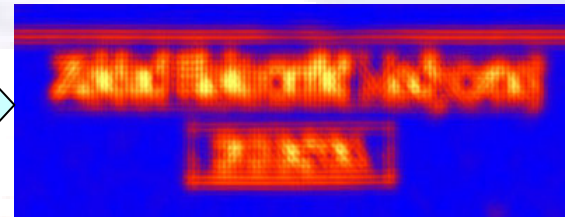
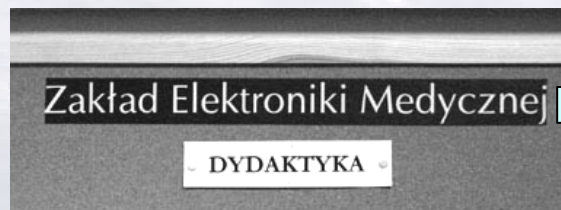
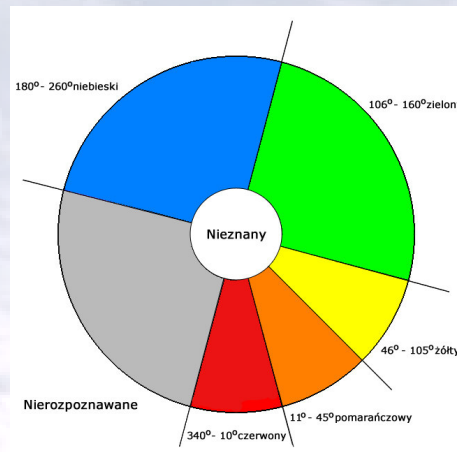
The screenshot displays the RemoteAssistant interface. On the left, a video window shows a first-person view from a camera held by a user, with a '4kBps' label at the bottom right. Below the video are icons for voice call, video call, camera, and volume, along with a status bar showing the IP address '83.220.111.70', a signal strength indicator '90', and an 'Uplink' indicator with a red arrow. At the bottom left, there are three speaker icons with data transfer rates: '1.98MB', '1.88MB', and '1.06MB'. On the right, a large map window shows a digital map with a red square indicating the user's position and a black line representing a path. Above the map is a yellow callout box with the text 'digital map with the position of the blind user'. The map interface includes a search icon, a refresh icon, a back arrow, a folder icon, a red path icon, and a compass icon. The entire interface is framed by a blue border with a red dashed line.



Smartphone with speech synthesis

Symbian smartphone assisting the blind:

- phone functions
- speech synthesis
- GPS navigation





prof. Korzec inaugural lecture



Outlook to 33 years ahead?

Inaugural lecture given by prof. Korzec in 1975.



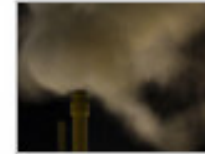
Engineering's Grand Challenges



Make solar energy economical



Provide energy from fusion



Develop carbon sequestration methods



Manage the nitrogen cycle



Provide access to clean water



Restore and improve urban infrastructure



Advance health informatics



Engineer better medicines



Reverse-engineer the brain



Prevent nuclear terror



Secure cyberspace



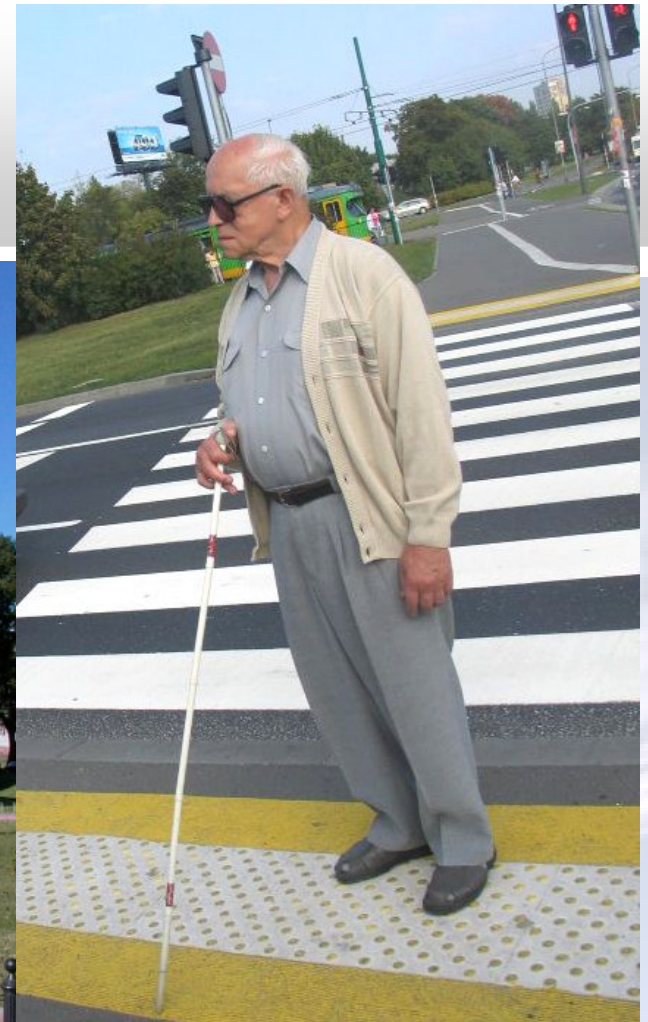
Enhance virtual reality



Advance personalized learning



Engineer the tools of scientific discovery





Acknowledgments

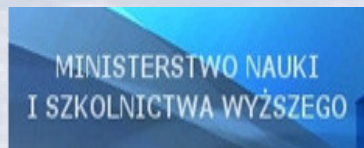


The blind volunteers taking part in the studies

Polish Blind Union, Lodz Region



*Colleagues and PhD students
from the Medial Electronics Division*



Ministry of Science and Higher Education