PALADYN

The construction of humanoid robotic head

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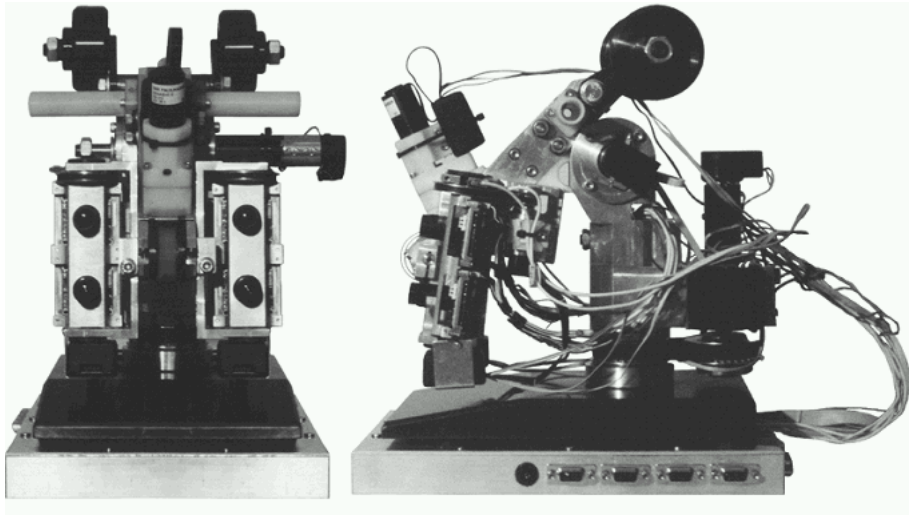
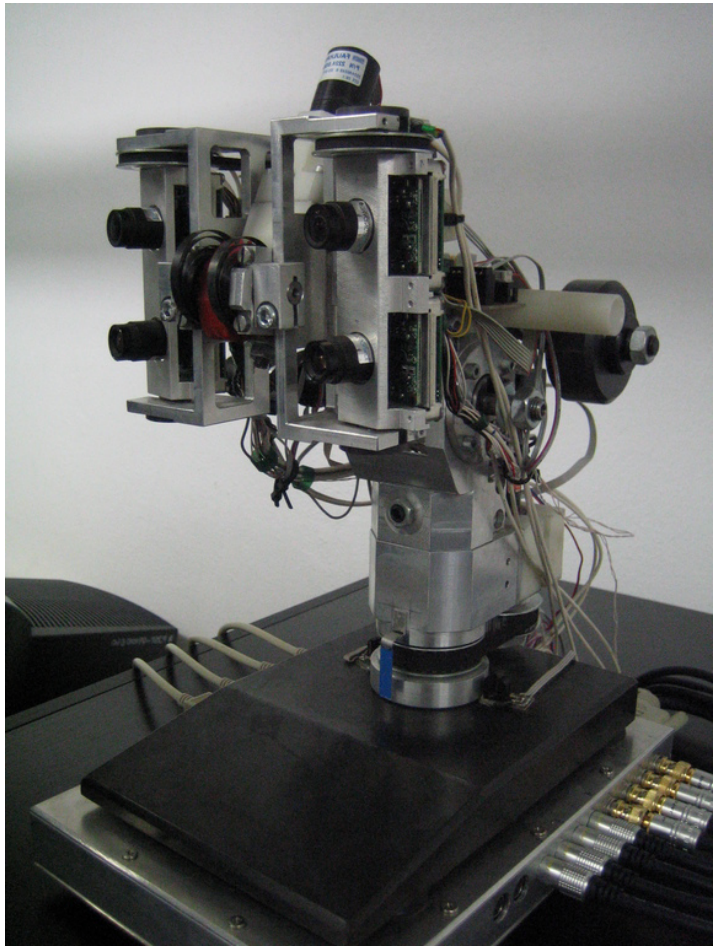


Polish-Japanese Institute of Information Technology. PJIIT Robotics and Multiagent Systems Lab. Poland.

PRESENTATION OUTLINE

HARDWARE OVERVIEW

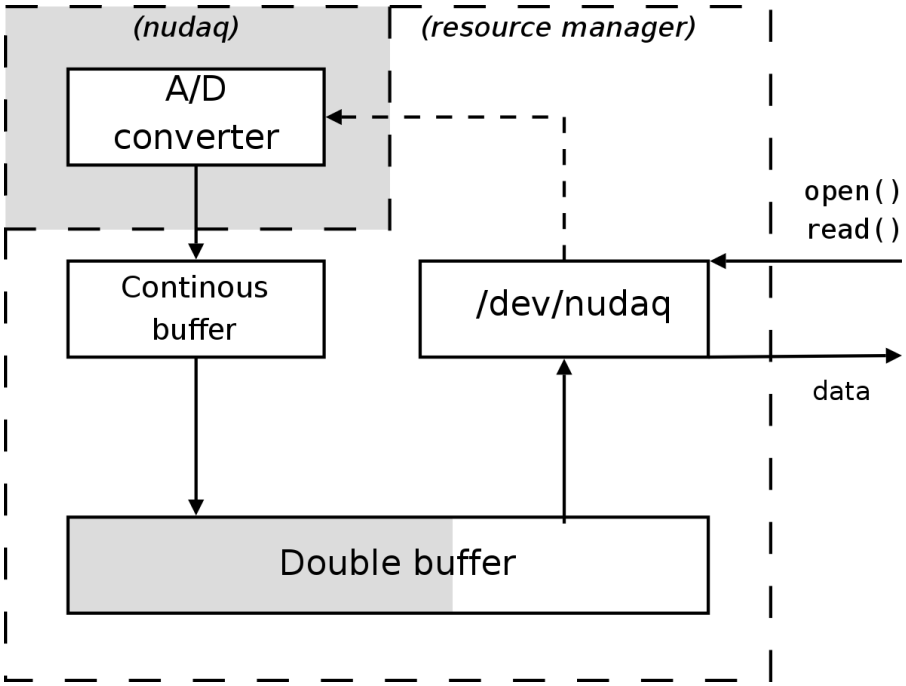
- 5 DoF, based on early Cog design, avoid using custom boards
- Visual, auditory, vestibular and control
- 4 CCD cameras: ImagingSource DFM 5303P and BT878 based PXC-200F framegrabbers
- Microphones with low-noise pre-amplifier
- 3 axis accelerometer/gyro & NuDAQ 9112 A/D
- Motion control: Galil DMC-1850



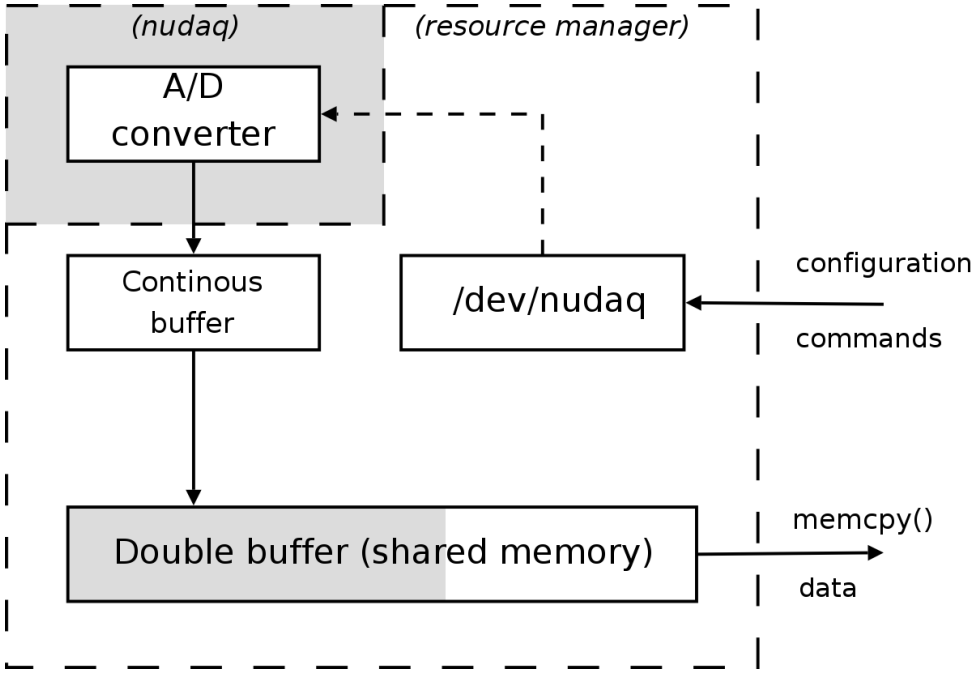
SOFTWARE OVERVIEW

- QNX RTOS nodes: vision (SMP), binaural localisation, motor control. . .
- Hard real time system essential for control tasks
- Shared memory for intra-node communication
- QNET Network transparency for inter-node communication
- `btlib`, `libmotors`: BT848/878 and Galil QNX libraries developed in our Lab
- Various other libraries: `OpenCV`, `FFTW`, `dmcqnx`, `pxc200`

DRIVER ARCHITECTURE

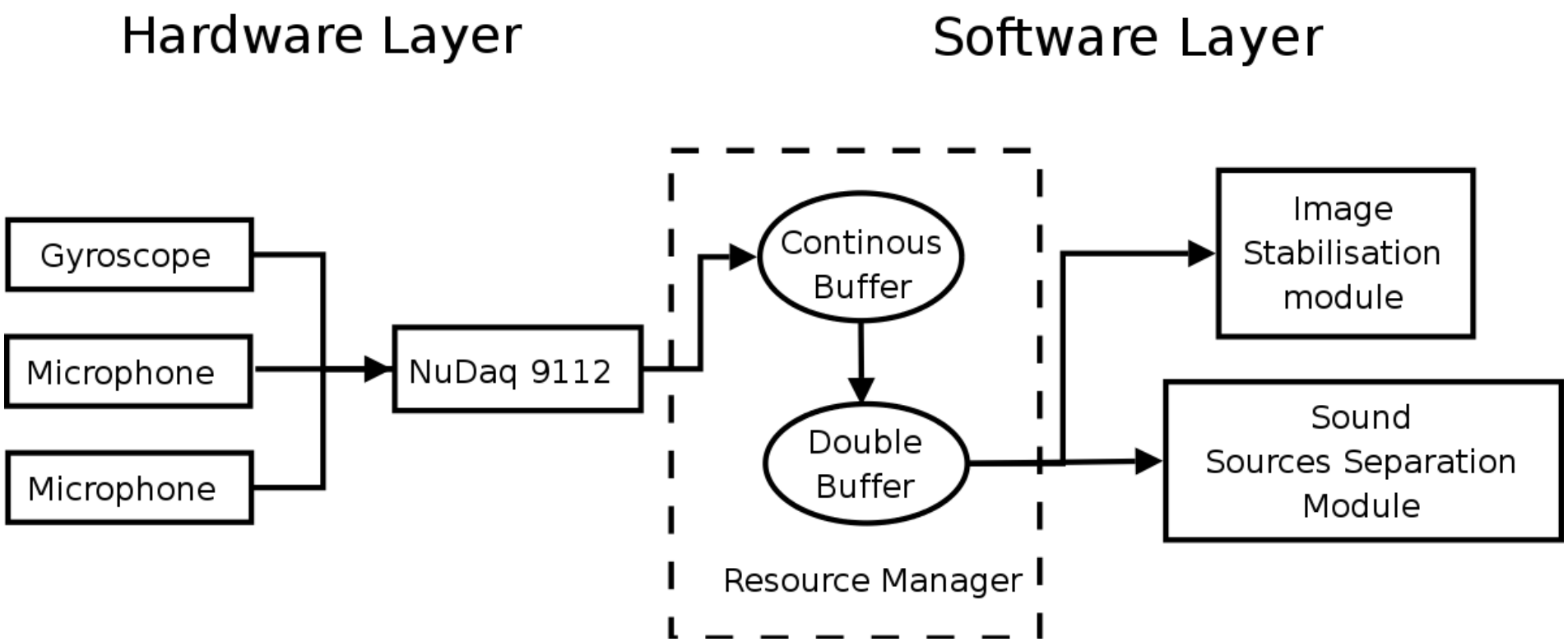


Pure resource manager model

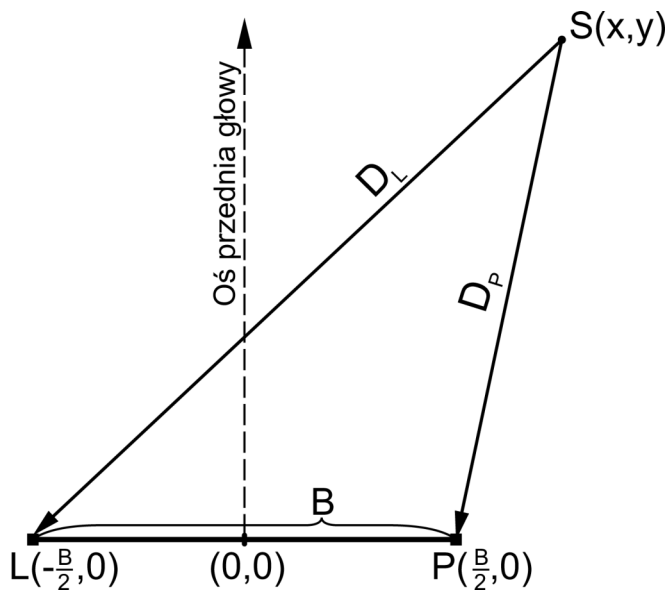


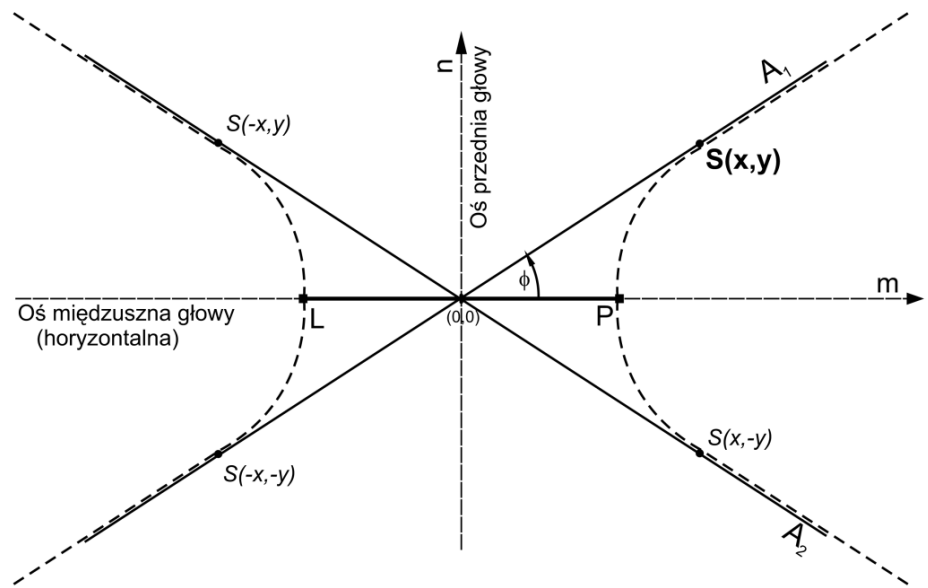
Our hybrid resource manager

DATA ACQUISITION SCHEME



BINAURAL LOCALISATION





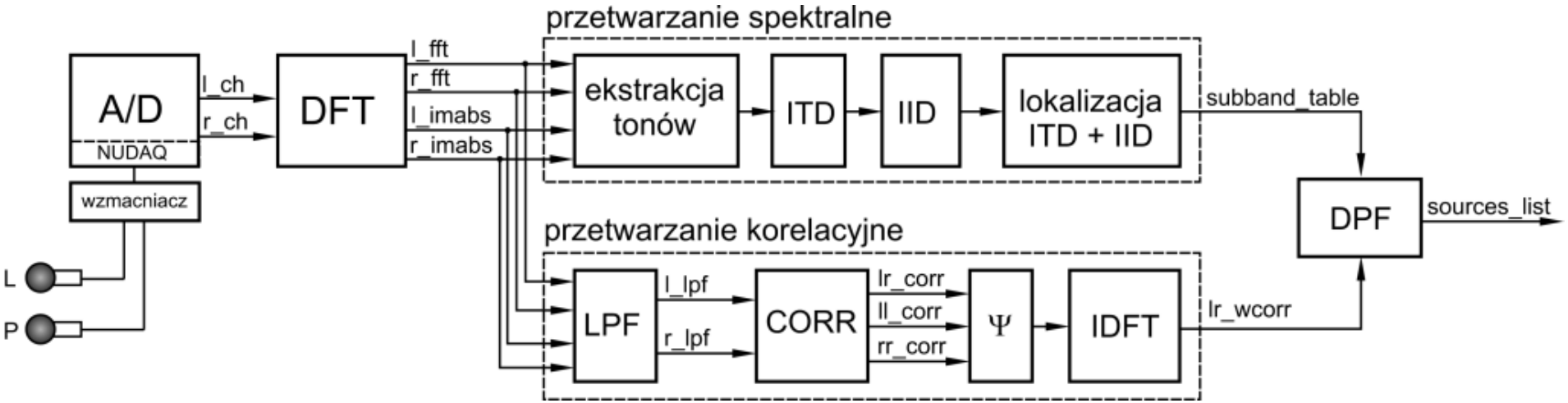
Geometrical problem overview

- Duplex theory: simple ITD and IID physics
- $IDD = D_{left} - D_{right} = ITD \times V_{sound}$

Ambiguity

- Directional uncertainty: front-back & left-right
- Path differences producing similar ITD values

BINAURAL SYSTEM DESIGN



Data acquisition:

- A/D conversion
- window function
- DFT processing (fftw library)

Spectral & correlation proc.:

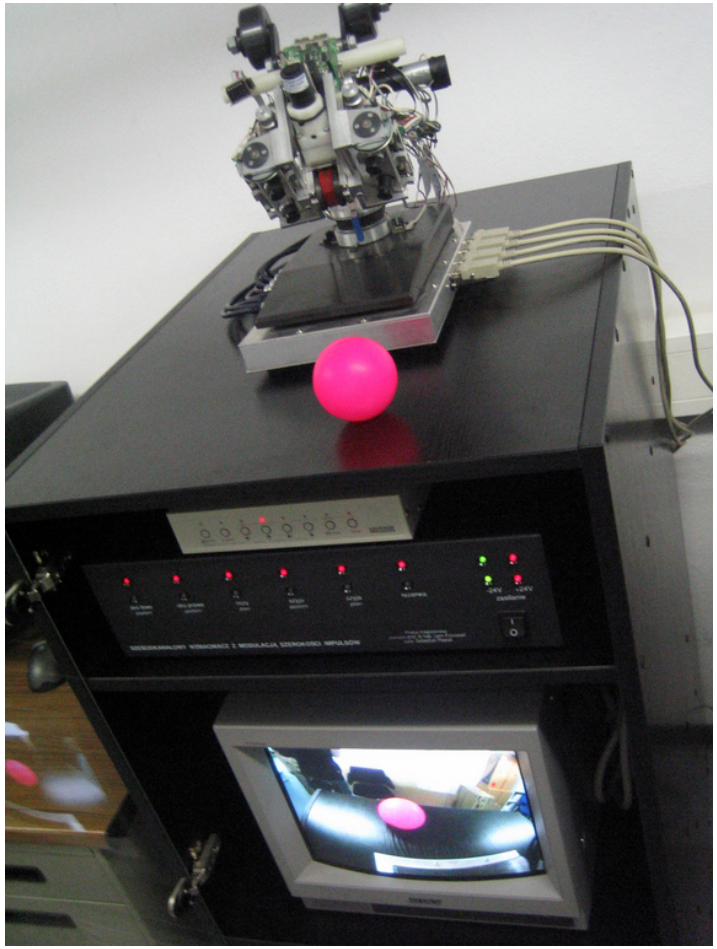
- tone extraction
- ITD and IID calculation
- IID enforced ITD calculation

Post-processing:

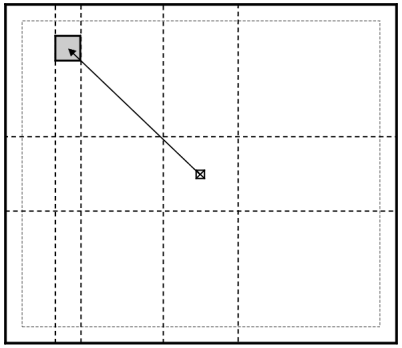
- low-pass filtering
- half-wave rectification
- SCOT Transform

MATCHING EYE MOVEMENTS

- So far implemented: voluntary movements: saccades, smooth pursuit, vergence.
- All voluntary movements were based on very simple normalised cross correlation
- Partially implemented: VOR, OKR
- Pre-attentive cues: motion, color, skin-tone
- Other saliency maps: habituation, sound source localisation (aids attention), no stereovision yet

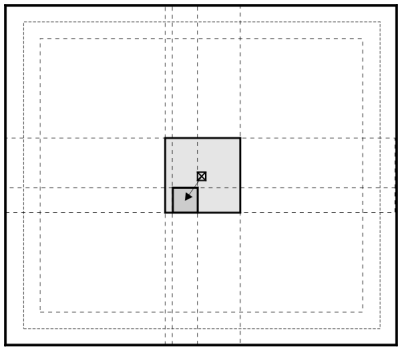


VOLUNTARY EYE MOVEMENTS

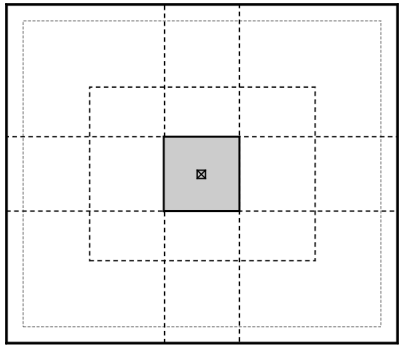


Before saccade: saving target patch

Saccade

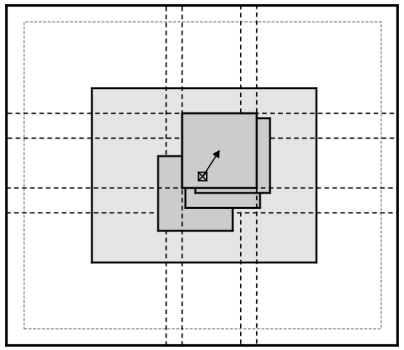


After saccade: correlating against target

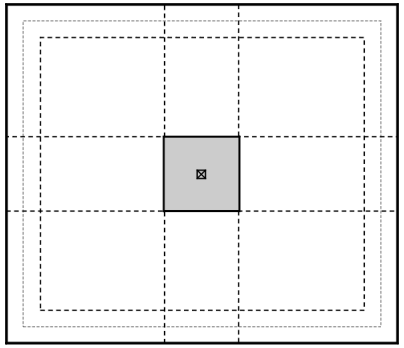


Before pursuit: saving central patch

Smooth pursuit

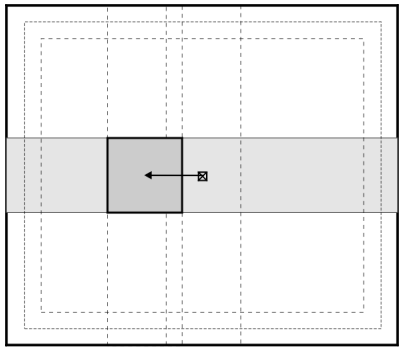


During pursuit: measuring displacement



Non-dominant eye: saving central patch

Vergence



Dominant eye: measuring vergence error

PREATTENTIVE CUES

Different saliency maps

- motion segmentation,
- habituation, sound sources,
- (color, skin tone extraction)

Motion and sound

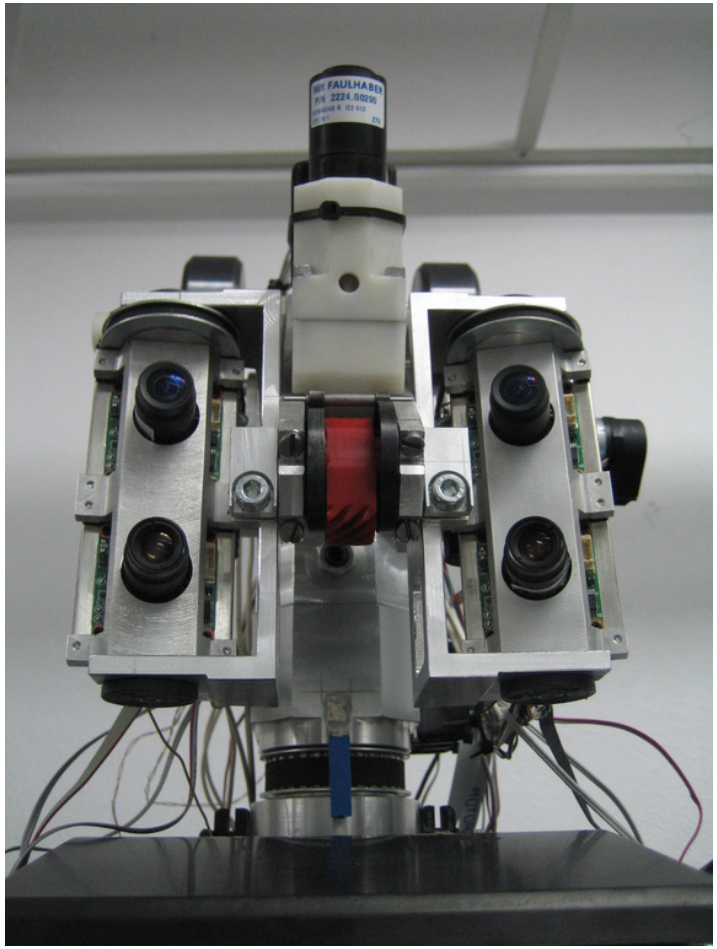
- sound aids visual attention
- bar width: probability
- bar value: signal strength

Habituation and sound

- activation: weighted sum
- target selection: centroid of the biggest region→saccade

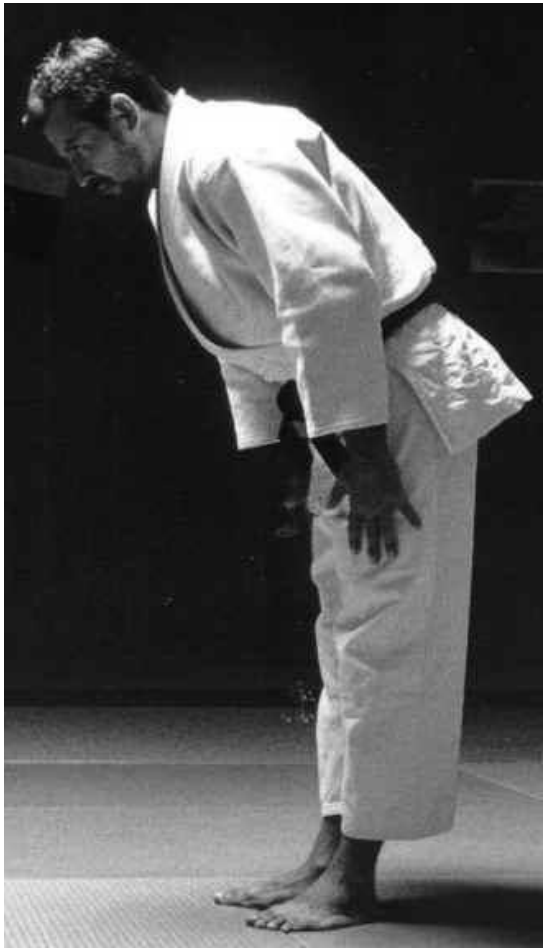
FUTURE WORK

- Develop cognitive vision system that learns from observation
- Start working with log-polar representation, implement new vision algorithms
- New analytical model for auditory cue templates (based on scattering theory)
- Develop STM memory module utilising real-time in-memory database system
- Make PALADYN work with YARP



QUESTIONS

Thank You.



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