Chiroptera-Inspired Robotic CEphaloid

Period:
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Partners:
Universiteit Antwerpen
Universität Erlangen-Nürnberg
Katholieke Universiteit Leuven
Bath University
University of Edinburgh
Syddansk Universitet (MIP)
Project work plan
Challenges: artificial pinnae

beamforming shapes to model the directivity of the bat's sonar system

- automatic procedure for extracting pinna morphology and associated directivity: CT-scanner + 3D-shape extraction + 3D FEM-analysis
- directivity effects due to tragus
- automatic procedure for generating artificial pinnae (laser-sintering)
- measurements to validate simulation results on pinna prototypes
Challenges: generate/receive ultrasonic sound

EMFi-based transducers & efficient drivers/receivers

- different EMFi-based (ferroelectret) emitters were assembled and their sound output + directivity measured
- CIRCE drive amplifier: 800 Vpp with a bandwidth of 200 kHz in a 250 pF capacitive load
- different broadband and small-size (attached to pinnae) EMFi-based receivers were assembled and their sensitivity measured
Challenges: neuromorphic processing

neuromimetic hardware for real-time signal processing

- the cochlear model reproduces functionally salient features of the bat’s neural code, e.g., quantitatively similar, at the expense of model accuracy
- the model is implemented in a single Xilinx VirtexII XC2V6000 FPGA chip running at 80MHz + PCI interface (1MSamples/sec)
- the model consists of user-programmable bp-filters, hw-rectifiers, lp-filters, AGC and neural spike generation: 300 channels (->700) in the frequency range 20kHz-200kHz, 16 spiking neurons/channel (->30)
Challenges: actuated sonar-head

- mechanical system for pinna movement & shape control
  - pre-tensioned cable driven differential mechanism, rotating the mounted pinna +/- 60 degrees with an accuracy of 0.1 degrees which exhibits practically no backlash
  - a linear nanomotor based setup for the rotation of the tragus through a lever mechanism
Challenges: realistic biosonar tasks

- experimental study of Doppler-based spatial mapping of the environment (“CF bats”)

- simulation study of spectrum-based spatial mapping of the environment (“FM bats”)

![Graphs and images illustrating biosonar tasks and mapping results.](image-url)
Challenges: realistic biosonar tasks

- Simulation study of how outer ear shapes, transmitter/receiver shape relate to performance in biosonar tasks