Smart Biosonar Sensors from Bats — the ChiRoPing Project

http://www.chiroping.org/

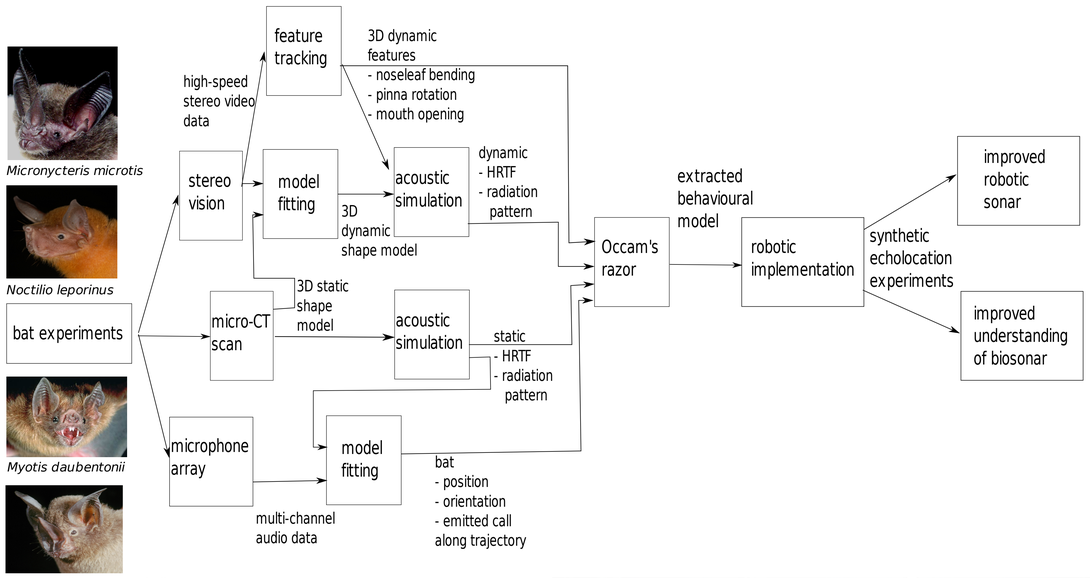
John Hallam, Herbert Peremans, Annemarie Surlykke, Robert B. Fisher, Elisabeth K. V. Kalko, Peter Møller Juhl

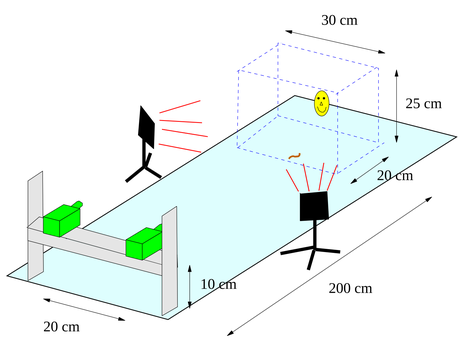
1 Introduction

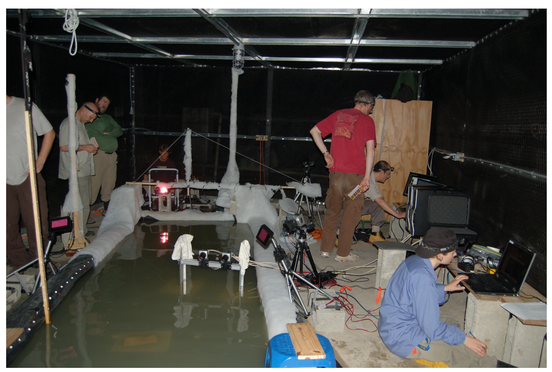
The ChiRoPing project aims to elicit useful principles from the hunting behaviour of four species of echo-locating bat which will be exploited in the development of robust and versatile biosonar-inspired sensors. The bats studied hunt on the wing, and capture prey which they detect and discriminate using a variety of echo-location calls and strategies. The key innovations of the project are a close collaboration between biologists and engineers and the in-depth study of the acoustic, flight and facial behaviour of the selected bat species during natural hunting tasks.

2 Methods

Shape, flight path and acoustic data captured during behavioural experiments are analysed in a variety of ways to reveal how bats exploit their facial morphology, call structure and flight choices to identify and capture interesting targets. The knowledge derived is used to inform robotic models of the sensing process, as illustrated in the figure below.





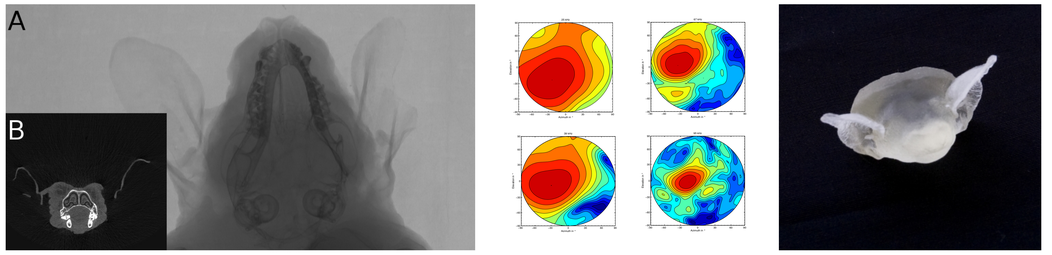


Data capture from a trawling bat, *Noctilio leporinus*: left, schematic organisation of cameras for stereo video sequence capture for trawling bats; right, setup of equipment (cameras, microphone arrays) in an artificial pond in the flight cage on Barro Colorado Island, Smithsonian Tropical Research Institute, Panama.

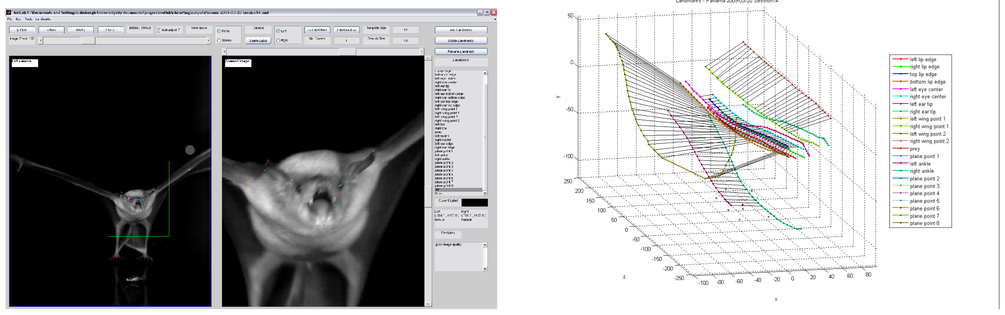
Acknowledgements

Funding for this work was provided by the EU Framework Programme 7 under contract IST 215370. Access to neotropical bats is provided by EKVK through the Smithsonian Tropical Research Institute facility on Barro Colorado Island, Panama.

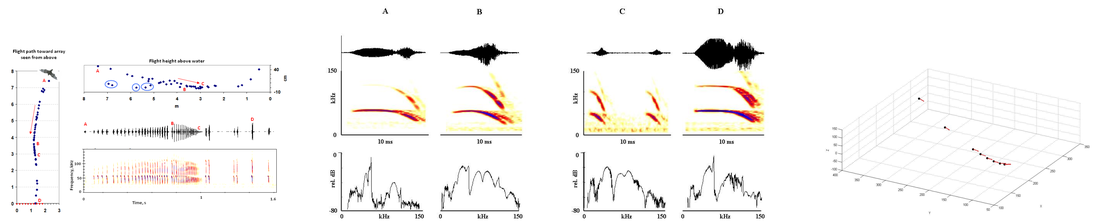
3 Results



Bat shapes are obtained by μCT scan, in this case for *Myotis daubentonii* (left), and can be used as input to acoustic simulation of the bat's head-related transfer function (centre) or for 3D printing of models (right).



Tools (left) developed by University of Edinburgh allow the tracking of interesting landmark points in the 3D stereo video sequences, and the reconstruction of sequences of their positions (right).



Acoustic array recordings allow computation of flight paths (left), analysis of call parameters (centre) and of sonar beam pointing direction (shown as short red lines in the figure to the right).

4 ChiRoPing Partners

- **University of Southern Denmark:** The Mærsk Institute [JH] coordinates the project and focusses on modelling the trawling bats; the Biology Institute [AMS] provides expertise in bat acoustic behaviour and access to Danish bat *Myotis daubentonii*; and the SENSE Institute [PMJ] contributes expertise in acoustic modelling and simulation.
- **University of Antwerp:** The Active Perception Laboratory [HP] focusses on modelling the gleaning bat *Micronycteris microtis*, and provides expertise in 3D scanning and acoustic simulation.
- **University of Edinburgh:** The Institute for Perception, Action and Behaviour [RBF] is responsible for capture and analysis of high speed, high quality stereoscopic and visual data.
- **University of Ulm:** The Institute of Experimental Ecology [EKVK] provides access to the neotropical bats used in the project, as well as extensive expertise in bat acoustics, behaviour and ecology.