Spatial Orientation in Vespertilionid Bats

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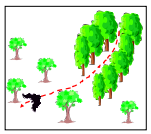
Introduction

Echolocation was primarily evolved for orientation in space (Schnitzler et al. 2003). According to orienting situations and the corresponding echolocation tasks three types of navigation can be distinguished: Small scale, middle scale and large scale navigation.

Small scale navigation:

All targets of interest are within the perceptual range of the echolocation system. This includes obstacle avoidance, landing control, identification of landmarks and prey localisation.



Middle scale navigation:

The goals of interest are beyond the range of the echolocation system but within the home range of the bats', e.g., in commuting flight on a route from the roost to a hunting habitat..

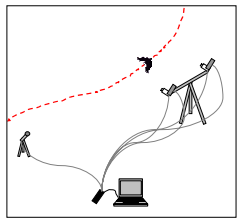
Large scale navigation:

The goals of interest are beyond the known home range of the bats, e.g. while migrating or homing. Echolocation plays little or no role in these situations.

We study middle scale navigation in some species of vespertilionid bats. Our main interest is to describe flight routes of individual bats in commuting flight in relation to the background.

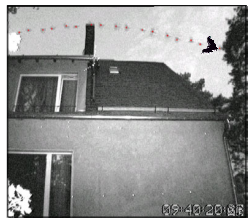
We also investigate the reaction in the echolocation and flight behaviour of bats to novel targets placed in various distances to the background.

Methods



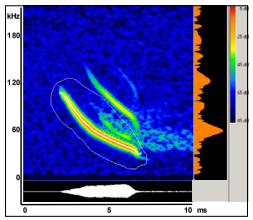
Recording of echolocation and flight behaviour

- Two IR-video cameras were spaced 2 m apart to record the flying bat. The scene is illuminated with IR strobe lights.
- An ultrasonic microphone is used to pick up the echolocation signals.
- A custom made A/D-transformer digitises the signals with a sampling rate of 480 kHz.
- Custom made software (PCTape) stores the signal sequences and synchronises video with sound recordings.



Three dimensional reconstruction of flight paths

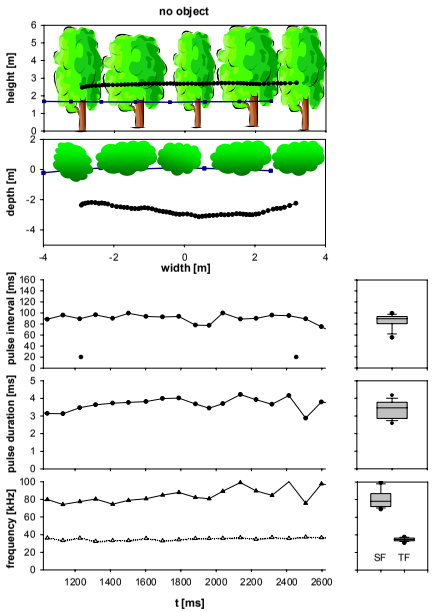
- Simi motion® software is used to reconstruct the flight routes of the bats in relation to the background by determining the three dimensional position of bats, background structures and novel targets.
- Accuracy of reconstruction
  - width (x) 1.7 %
  - depth (y) 2.7 %
  - height (z) 1.0 %

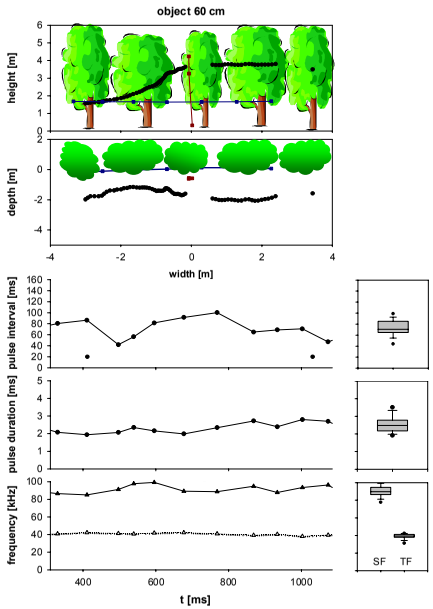


Sound analysis

- A custom made programme (Selena) is used to analyse the echolocation signals.
- For analysis we use an FFT of 256 and display the sonagramme (interpolated) with a time resolution of 0.02 ms and a frequency resolution of 470 Hz.
- We measure start frequency (SF) and terminal frequency (TF) (20 dB below maximum amplitude) and calculate bandwidth, pulse duration and pulse interval.

Results





Echolocation and flight behaviour in *M. brandtii* reacting to an novel object

- The reaction to the novel object placed in 60 cm distance to the background is indicated by a turn in the flight path.
- Echolocation behaviour remained unchanged while approaching and passing the object
- Differences in signal design may depend on horizontal distance to the background. In the left graph the pulse duration was longer and the bandwidth was lower than in the right graph.

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