Weakly electric fish as models for underwater robots

The use of active electrolocation for the perception of 3-dimensional objects in complex environments

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Introduction

***Gnathonemus petersii*:**
This African weakly electric fish generates electrical signals with an electric organ in its tail. During each electric organ discharge an electric field builds up around the fish (Fig.2).

Active electrolocation:
The animal perceives its own electrical emissions with epidermal electroreceptor organs. Objects are detected and distinguished by analysing the specific electric images, which are projected onto the skin of the fish.

Influence of backgrounds:
From the visual system it is known that noisy backgrounds enhance images contrast. Until now it is not known, how complex backgrounds interfere with object discrimination during active electrolocation.

Fig.1: *Gnathonemus petersii.*

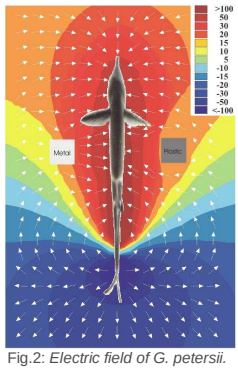

Fig.2: *Electric field of G. petersii.*

Questions:

1. Up to what distance can *G. petersii* discriminate between different objects?
2. Does the presence of various backgrounds influence the discrimination performance?
3. Can moving backgrounds improve object discrimination?

Results

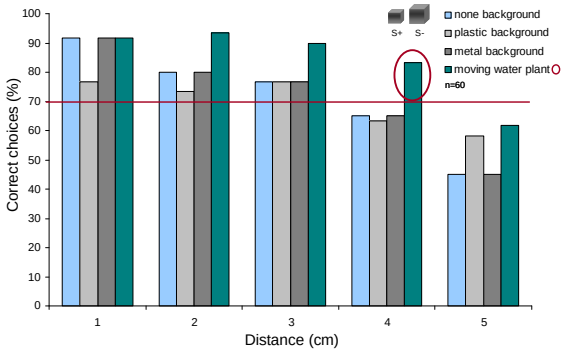

Fig.3: Distance measurements in front of various backgrounds.

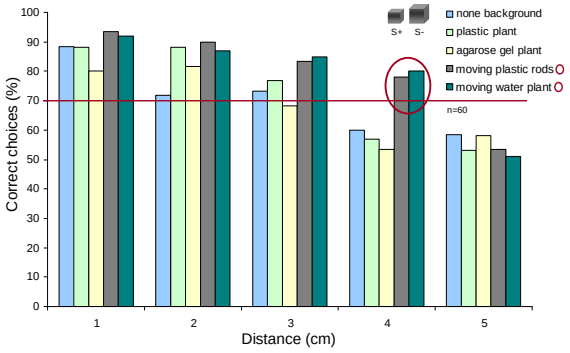

Fig.4: Distance measurements in front of moving / non moving backgrounds.

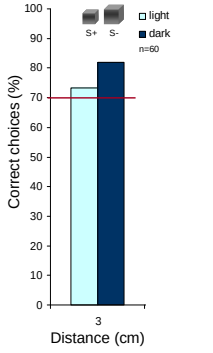

Fig.5: Control experiments.

Conclusions:

1. *G. petersii* can discriminate between differently shaped metal objects up to a distance of about 3 cm (Fig.3).
2. Large plastic and metal backgrounds do not impair object recognition (Fig.3).
3. Moving backgrounds (water plants; plastic rods) improve object discrimination (Fig.4).

Methods

Food-rewarded two-alternative forced-choice procedure:
Animals were trained to discriminate between objects of different shapes. Fish had to swim through one of two gates in order to make a decision and receive a food reward.

Thresholds for the maximal **distance** at which objects could be discriminated were obtained by presenting the objects at distances of 1cm to 5cm from the gates.

Different **backgrounds** were placed behind the objects, to measure whether they interfere with object discrimination.

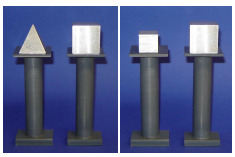

Fig.6: Trainingobjects.

Fig.7: Plastic-, metal-, water plant-, plastic plant-, agarose gel plant-, plastic rods background.

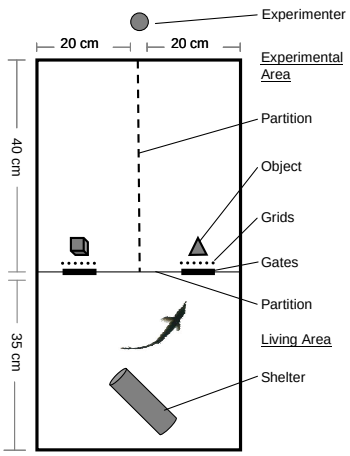

Fig.8: Experimental setup from above.