MOTION RECONSTRUCTION OF ARM SWIMMING IN THE OCTOPUS VULGARIS

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The arm swimming movement in the benthic common octopus was investigated in detail, by means of image segmentation and motion reconstruction of video data acquired by the authors. The 3D trajectories of all eight arms were tracked, for the first time, revealing a synchronous, albeit complex, pattern of motion.

Introduction

Arm swimming in the octopus is a mode of locomotion that is used by the animal primarily for hunting, defence, or escape [Huffard, 2006]. The motion, in general, is characterized by a fast closing of the arms and a slow opening of the arms [Sfakiotakis, 2012]. The movement has previously been discussed [Kazakidi, 2012], however the detailed kinematics is still unknown.

Methods

Video acquisition by three high-definition cameras (Sony PMW-EX1R, at 25 frames/s, with image resolution of 1080x1920) was used on adult octopuses, kept in the aquarium (*Octopus vulgaris*, 200-400gr of weight). The image sequences were a posteriori deinterlaced, synchronized, and compensated for radial and tangential lens distortion. Using a checkerboard pattern, the intrinsic and extrinsic calibration of each camera was performed, with a strong estimation of the camera parameters. To facilitate segmentation issues with distal to the camera arms, or occluded parts, reconstruction was performed only to video sequences with visible arms.

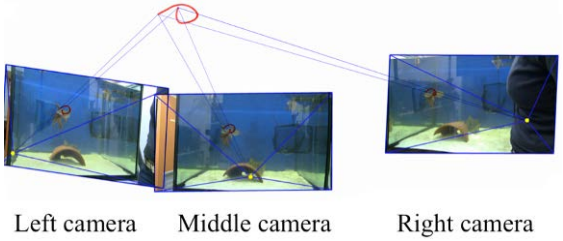

Figure 1: 3D reconstruction of one arm.

To reconstruct an individual arm in 3D, the 2D arm contour was manually segmented from each camera frame, and its medial axis was extracted, thereafter, automatically [Yekutieli, 2007]. Employing epipolar geometry constraints and least-square approximation, between each camera view, the reconstruction of each, corresponding, medial axis in 3D was obtained (figure 1). A back-projection process, from 3D to 2D, allowed evaluation and verification of the resulting 3D trajectories, via a manually iterative procedure.

Results

Figure 2 (right - R) displays a 3D view of the arms observed in the 2D image on the left (L).

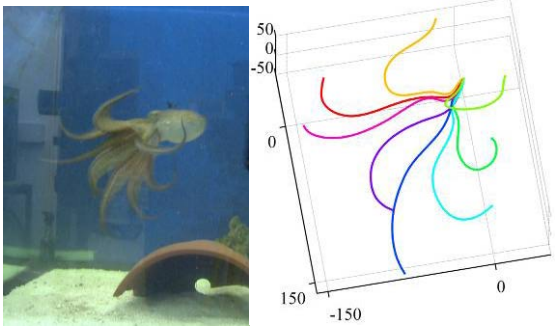

Figure 2: (L) 2D snapshot from one camera. (R) 3D reconstruction (the eye is at zero position).

Discussion

The 3D trajectories of the medial axes of octopus arms during arm swimming motion were robustly extracted from video sequences of live octopuses. This is the first demonstration of the complete 3D swimming motion of all eight individual arms. Additional data will provide new kinematic information.

References

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