Analysis-by-synthesis with Virtual Fishes as an Experimental Method for Mate-choice studies

In June 2012 the interdisciplinary, DFG-funded project of the Institute of Real Time Learning Systems (EZLS), led by Prof. Kuhnert and the Department of Biology and Didactics, led by Prof. Witte, started. The project consists of two parts. EZLS analyses fish's movements and behaviour with help of a computer vision system. The gathered information is used in the sequel to create a photo-realistic simulation of fishes and it behaviour. The biologists will use the virtual fishes in combination with real ones to conduct mate-choice experiments.

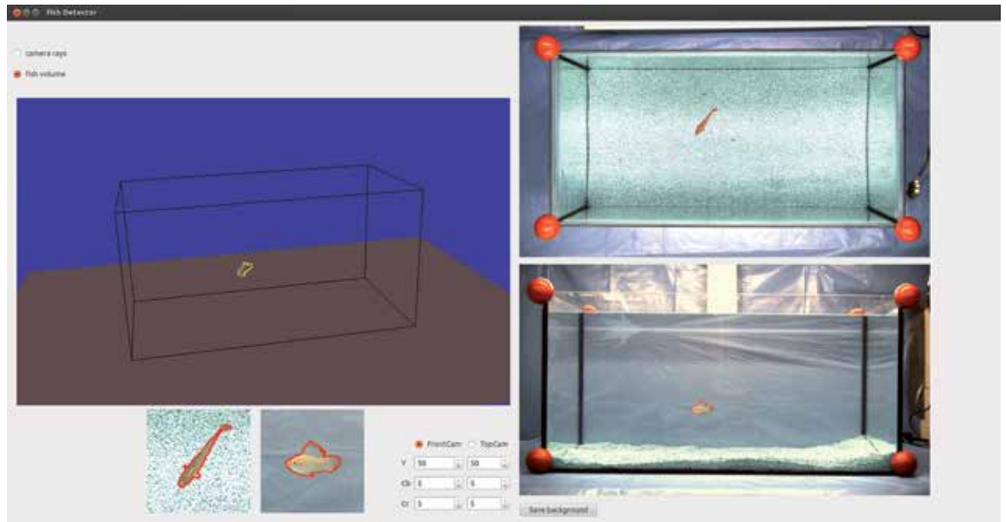
The used fish species is sailfin molly, which has a size of 4 to 10 cm and is able to move quite quickly and rather abruptly. Especially, its quick movements place special demands on the computer vision system.

For the estimation of fish pose and position a new approach based on analysis-by-synthesis is used. To generate ground-truth data a very precisely calibrated computer-vision system with two orthogonally aligned cameras calculates positions and poses of the fishes. This allows later on to quantitatively evaluate the results stemming from the new analysis-by-synthesis approach.

In the second phase a fish model is created with the help of the gathered shape, movement and behaviour information of the species. This steerable virtual fish can be used by the biologists to conduct fish-behaviour experiments under strictly controlled conditions.

Furthermore, the model is utilised to build a tracking system based on analysis-by-synthesis. This approach allows to track the fishes' 3D-position and 3D-deformation by using only one camera. Due to the model's information about fish's movements the algorithm renders the most probable image of the virtual fish and compares this to the captured image of the real fish. This step is repeated until the rendered image becomes undistinguishable from the captured image. As a result the algorithm provides the best fit model parameters and consequently a complete fish description in 3D.

With the help of the tracking information of the real fishes the virtual fishes which are projected onto a screen can react to and also interact with the real fishes. This powerful tool will open up a new way to the biologists in conducting fish-behaviour studies.



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