Mapping the Navigational Information Content of Insect Habitats

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For developing and validating models of insect navigation it is essential to identify the visual input insects experience in their natural habitats. Here we report on the development of methods to reconstruct what insects see when making navigational decisions and critically assess the current limitations of such methods.

We used a laser-range finder as well as camera-based methods to capture the 3D structure and the appearance of outdoor environments. Both approaches produce coloured point clouds that allow within the model scale the reconstruction of views at defined positions and orientations. For instance, we filmed bees and wasps with a high-speed stereo camera system to estimate their 3D flight paths and gaze direction. The high-speed system is registered with a 3D model of the same environment, such that panoramic images can be rendered along the insects' flight paths (see accompanying abstract "Benchmark 3D-models of natural navigation environments @ www.InsectVision.org" by Mair et al.).

The laser-range finder (see figure A) is equipped with a rotating camera that provides colour information for the measured 3D points. This system is robust and easy-to-use in the field generating high resolution data (about 50×10^6 points) with large field of view, up to a distance of 80 m at typical acquisition times of about 8 minutes. However, a large number of scans at different locations has to be recorded and registered to account for occlusions.

In comparison, data acquisition in camera-based reconstruction from multiple view-points is fast, but model generation is computationally more complex due to bundle adjustment and dense pair-wise stereo computation (see figure B, C for views rendered from a 3D model based on 6 image pairs). In addition it is non-trivial and often time-consuming in the field to ensure the acquisition of sufficient information. We are currently developing the tools that will allow us to combine the results of laser-scanner and camera-based 3D reconstruction methods.