Optimized Snapshot-based Visual Homing for UAVs

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Our Topic

The focus of the research was to develop an efficient method of visual homing for a UAV. The aim was to demonstrate a UAV's ability to navigate without the use of GPS.

Related Work

A Framework for Visual Return-to-Home Capability in GPS-denied Environments
By Benjamin P. Lewis and Randal W. Beard

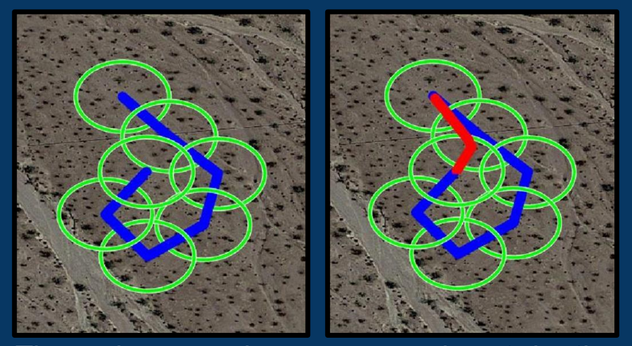
A Sparse Snapshot-based Navigation Strategy for UAS Guidance in Natural Environments
By Aymeric Denuelle and Mandyam V. Srinivasan

Flight Path Planning for Unmanned Aerial Vehicles with Landmark-Based Visual Navigation
By Luitpold Babel

Methods

A GPS-less homing system was developed using the computer vision library OpenCV and MATLAB. The MATLAB simulation used homography control law to achieve visual homing and was modeled off of the work of Lewis and Beard. Comparing features of snapshots in OpenCV generated near optimal flight paths.

These images show an experiment in the suburb environment. The blue path represents the exploratory journey, the red path the return journey, and the green circles the snapshots. The path optimized from the goal location directly to home (the center of the image).



These images show an experiment in the desert environment. The path optimized from the goal location to the second snapshot. From there, the UAV retraced its exploratory journey to home (the top of the image).

Experiments

To test the simulation, a UAV was tasked to navigate home in three different environments: a suburb, a desert, and a forest. For each randomly generated outbound path, the UAV would navigate back to home along both the original path, and the optimized path.

Results

Test	Successful Homing	Successful Optimized Homing	Average Distance Reduced	Average Time Saved
Suburb	87%	85%	48%	84 seconds
Desert	100%	67%	54%	95 seconds
Forest	93%	50%	59%	104 seconds

Future Work

- Improve robustness of homing method
- Refine visual path optimization
- Simulate realistic flight dynamics
- Test in different environments
- Simulation of a fixed wing aircraft
- Implementation on physical aircraft