Sky-Watch: Drone-based Architectural Scanner
A semi-autonomous, coordinated drone system for 3D reconstruction of structures for architectural profiling
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Goals
- Create a system to implement a Multi-Agent Reinforcement Learning framework for 3D reconstruction
- Improve speed and flexibility of image collection using drones

Motivations and Objectives

Design Goals
- Quick & Efficient method of structure profiling out of human reach
- Data consolidation: multiple image/video streams → one cohesive model
- Drones are becoming cheaper and more accessible as a means of photography

Objectives
- Prove RL on drones is cheaper and faster than human piloting
- Provide an accessible means for visual data collection to insurers, civil engineers, archaeologists
- Open the door to future RL focused, drone-implemented, 3D reconstruction methodology research

Methodology

Robot Operating System (ROS)
- Portable system for managing the coordination of robots and data transfer between robots and computers
- Stable on popular Linux distros

Reinforcement Learning (RL)
- Human decision-controlled vs Q-Learning determined paths
- Respond to high priority areas to create the best point-cloud as quickly as possible

“Grid System” to Cover Surface Area
- One grid per “face” of structure
- RL-informed drone movements through each grid
- Keep drones on their own grids for safety

Structure From Motion (SFM)
- 3D reconstruction from pictures
- Scalable from multiple image sources
- Low bandwidth

Simultaneous Localization and Mapping (SLAM)
- Real-time
- Bandwidth intensive
- Not easily scalable
- Useful for human-in-the-loop targeting

Research Challenges
- Create a system that is scalable and portable
- Ability to interface with different drones
- Keep cost low
- Keep accessible to future R&D
- Compare methods of 3D reconstruction
- Optimizing Speed v. Quality
- Reconstruction using multiple agents

Reconstruction using multiple agents
- Combining point clouds
- Consolidating image/video inputs

Results

3D reconstruction of a structure

Sky-Watch SFM Control System
- Monitor for incoming pictures
- Parse face, column and row data
- Output reward values for reinforcement learning after initial exploration phase
- Create matching lists based on previous images
- Add edge cases between faces to matching list
- Execute spare reconstruction

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References
J. Engel, T. Schöps, B. Cremers, LSD-SLAM: Large-Scale Direct Monocular SLAM, ECCV 2014

An example of a large complex structure and its densely reconstructed point cloud.