3D Reconstruction from video imagery for persistent surveillance of urban scenes

Alexandru N. Vasile, Octavia I. Camps & Mario Sznaier

Dept. Of Electrical Engineering

RICC 2010

19 October 2010

This work is sponsored by the Department of the Air Force under Air Force Contract FA8721-05-C-0002. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the United States Government.
Objective:

- Fuse city-sized video imagery collected from an airborne platform to data collected from a near-ground platform with a markedly different perspective.

Applications:

- Persistent surveillance for target tracking through occlusions.
- Autonomous path planning for ground or other low-flying UAVs.
- Geo-registration and fusion with other data sources, such as 3D Lidar.

Video Sources:

- 15Kft airborne platform with 60 Mpixel grayscale camera operating at 2Hz, with GPS/INS system.
- Ground vehicle or organic UAV with HD resolution camera and low-grade GPS.

Proposed Approach:

- Reconstruct the 3D underlying scene. Use bundle adjustment algorithm to construct a sparse 3D data set of the urban scene from the airborne platform.

Bundle adjustment

- Minimizes the re-projection error between the image locations of observed and predicted image points.
- Error expressed as sum of squares of non-linear, real valued functions.
- Minimize using Levenberg–Marquardt algorithm (LMA).

PMVS – Patch-based Multi View Stereo

- Based on the intrinsic + extrinsic parameters obtained from bundle adjustment, derive dense 3D reconstruction using sift patches.

Results – Sparse 3D Map

- Height Color Coded 3D Map
  - Blue – Low altitude
  - Yellow – Med altitude
  - Red – High altitude

Future Work

- Create a dense 3D/gray-scale fused data set using PMVS.
- Register ground-collected video data, locally re-compute bundle adjustment to improve the existing 3D reconstruction.

This work is sponsored by the Department of the Air Force under Air Force Contract FA8721-05-C-0002. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the United States Government.