Multi-View Geometry and Computational Photography Using Non-Classical Cameras

Amit Agrawal and Srikumar Ramalingam

Mitsubishi Electric Research Labs (MERL)

Schedule

9:15 Introduction and Geometry of Rays

9:45 Modeling Non-Classical Cameras

10:30 Break

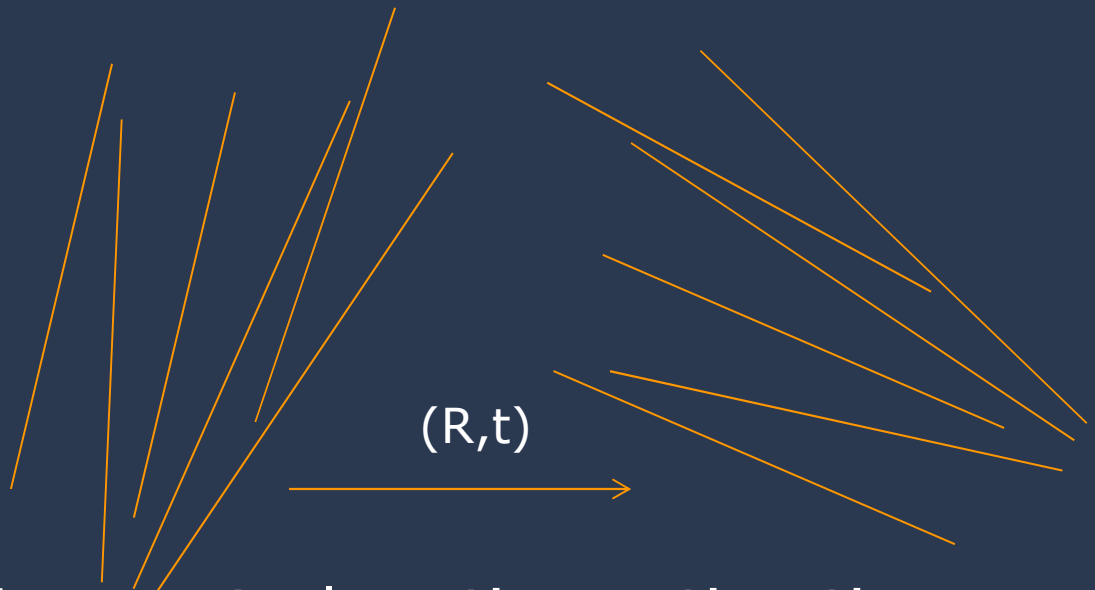
10:45 Calibration and Multi-View-Geometry

11:30 Break

11:45 Synthesis/Reconstructions

12:30 Future Directions and Discussions

Unsolved Problems: Degeneracies in Motion Estimation for Axial Cameras



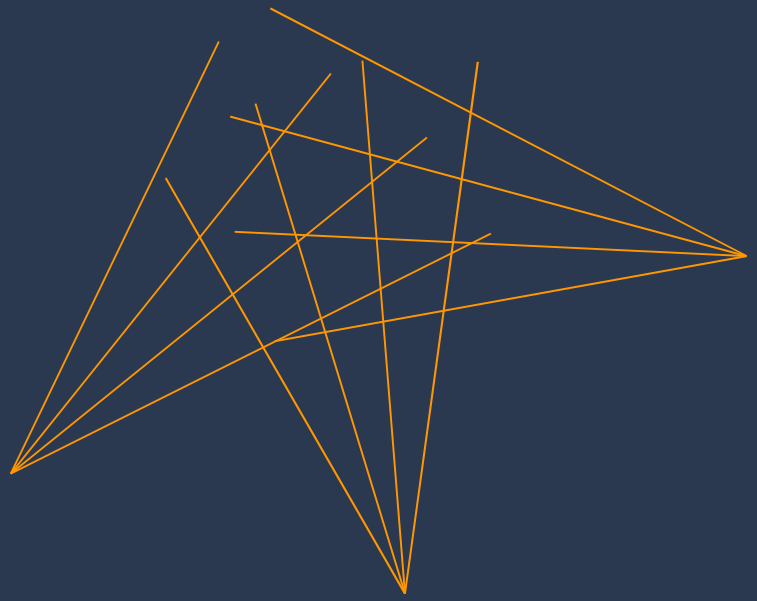
- 6-Point Non-central motion estimation
  - H. Stewénius, D. Nistér, M. Oskarsson, and K. Åström. Solutions to minimal generalized relative pose problems. In Workshop on Omnidirectional Vision, Beijing China, October 2005.
  - 64th degree solution
  - However fails in some special cases (locally central)

Uncalibrated Motion Estimation

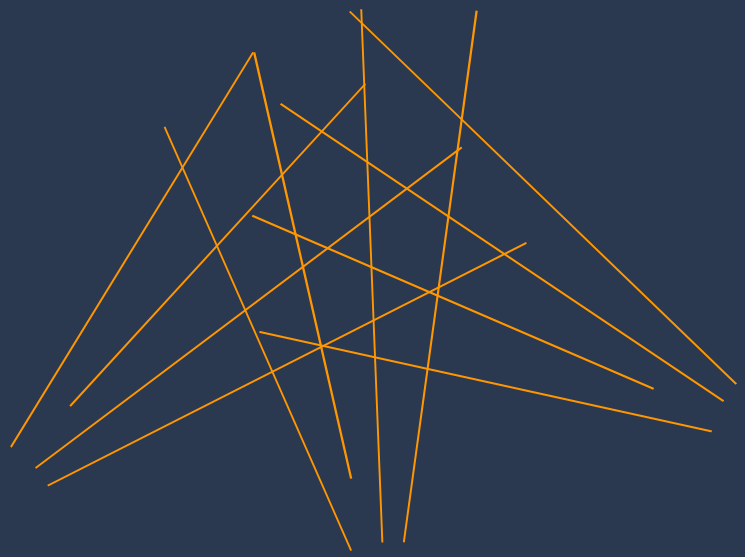
- For classical cameras, 3 by 3 fundamental matrix captures the calibration and motion information
  - Larger fundamental matrix for central catadioptric cameras
    - Geyer and Stewanius, CVPR 2007
    - Sturm and Barreto, ECCV 2008

- Non-classical cameras ?

3-view 4-point motion estimation



[Nister and Schaffalitzky ECCV 2008, Li et al CVPR 2010]



Non-classical scenario (Unsolved)

3-view 6-line Motion Estimation

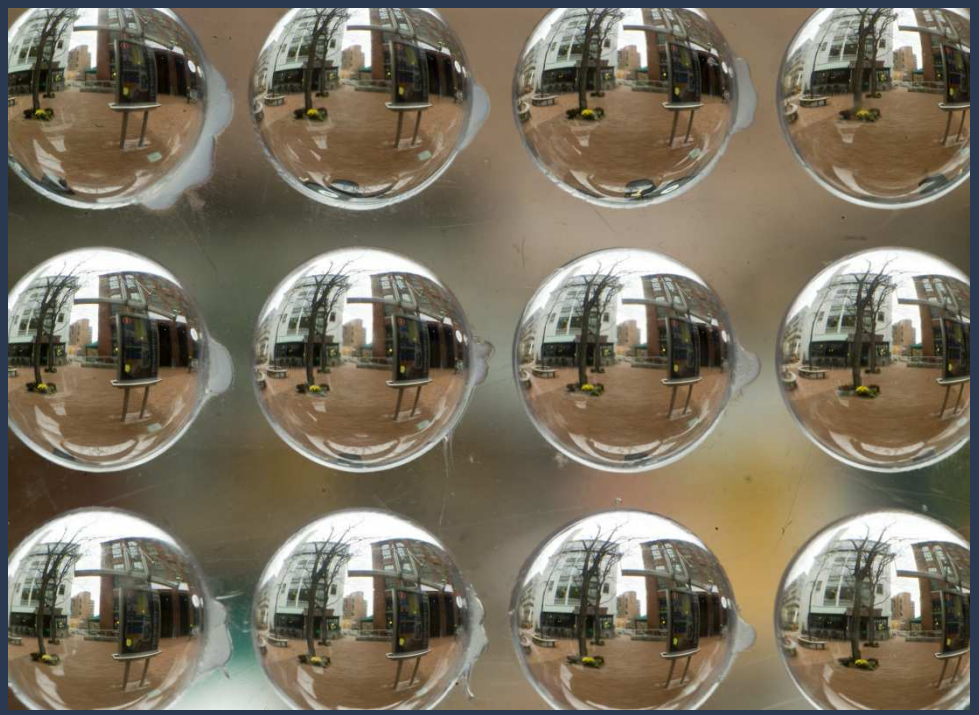
- Classical case:
  - Unsolved
- Non-classical case:
  - 3D lines can be reconstructed with a single image in non-central cameras and
  - 3D line-line registration can be used for motion estimation.

Self-calibration of non-classical cameras

- Several calibration grid based algorithms exist for catadioptric, non-central and generic models.
- Self-calibration algorithms, which do not use any calibration grids, are not robust and accurate for non-classical cameras.

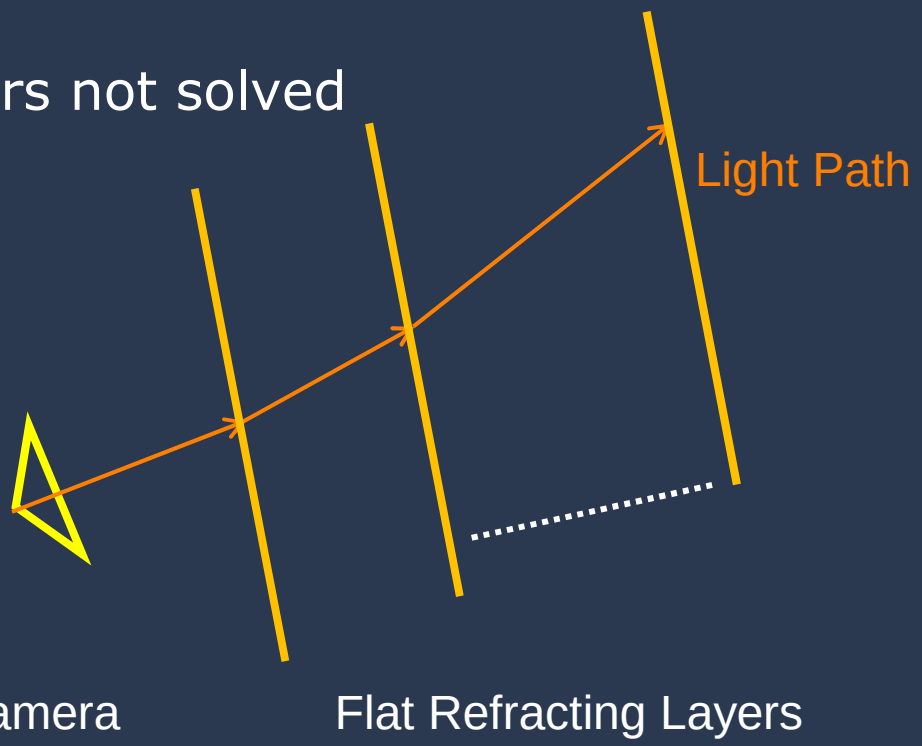
Calibration for multi-mirrored systems

- Plane based calibration of
  - Refractive Spheres
  - Spherical refractive array
  - In general curved refractive surfaces



Axial Light-Path Calibration

- Planar Refractive Surfaces
  - Agrawal et al CVPR 2012
  - Cannot not solve general case of two layers
  - Two or more layers
  - Case of non-parallel layers not solved



General Light-Path Calibration

- Multiple planar reflections
  - Currently manual intervention is required

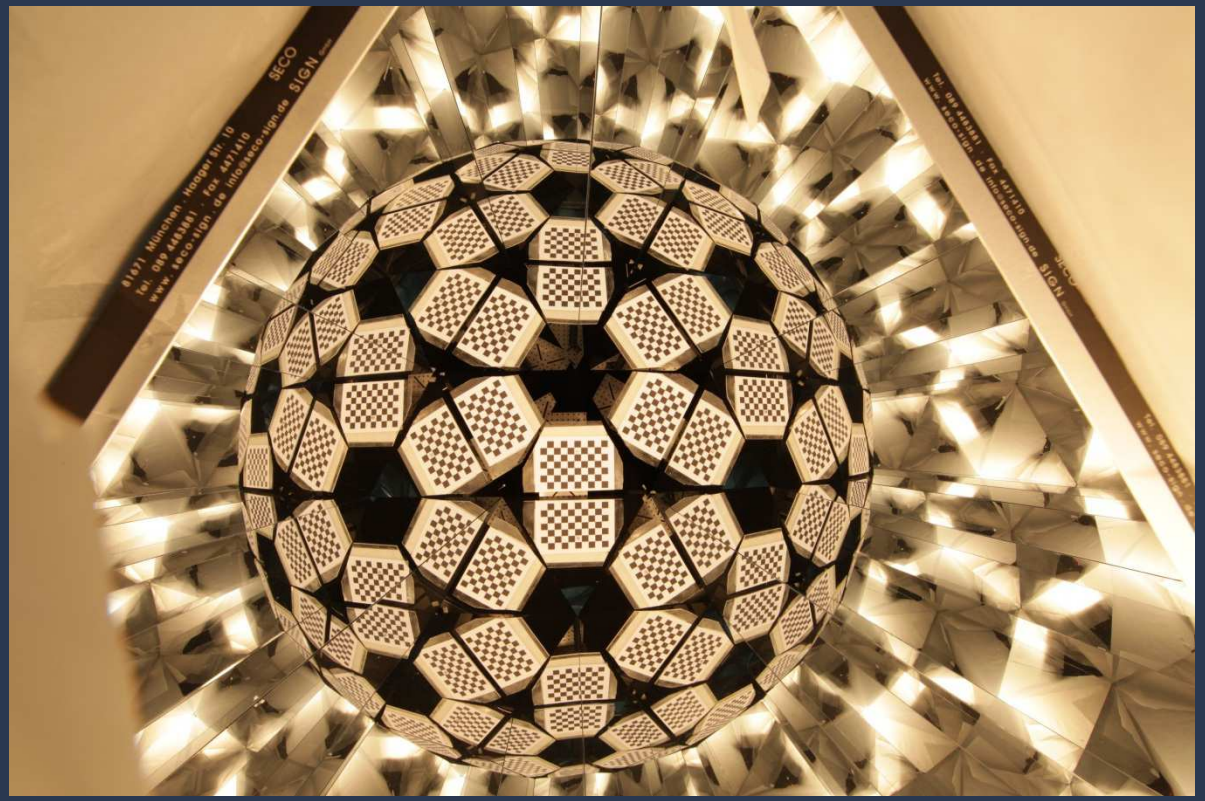


Image Courtesy: Prof. Ivo Ihrke