Group of Robotics and Cognitive Systems
http://robotics.pme.duth.gr/

School of Engineering,
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Localization of Planetary Exploration Rovers with Orbital Imaging: a survey of approaches

Evangelos Boukas, Antonios Gasteratos and Gianfranco Visentin

Presentation's Outline

- Motivation
- ESA Network/Partnering Initiative
- Survey:
  - Descent Imagery
  - Skyline (animated)
  - Terrain Matching (animated)
- Assessment Framework
- Conclusion

Motivation

- Advanced space missions require increased autonomy
- Localization is sine qua non for Space Exploratory Rovers

ESA Network/Partnering Initiative

- European Space Agency co-funds and supports PhD and post-doc research
- Main objectives:
  - Strengthen the links among ESA, Universities, Research institutes and Industry
  - Apply recent non-space technology to space programs
- Provides:
  - Co-funding
  - Access to ESTEC laboratories (6-12 months)
  - Technical support
  - Networking via ESA links

ESA Network/Partnering Initiative

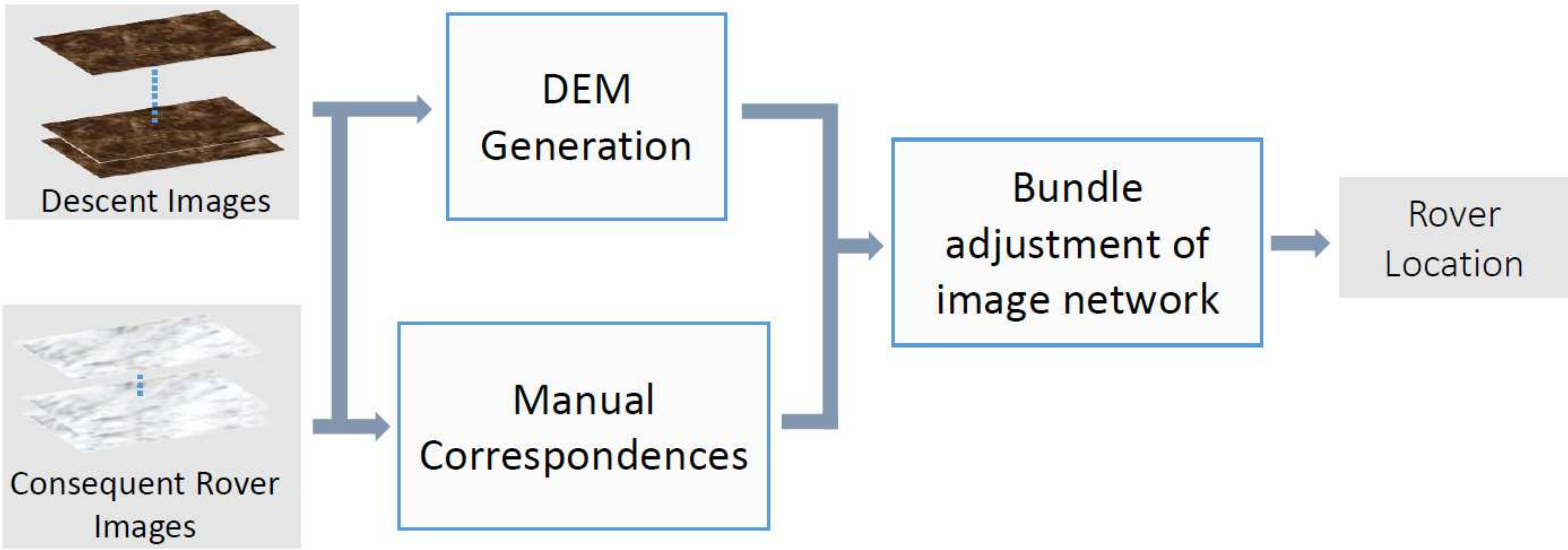
- Laboratory of Robotics and Automation, School of Engineering, Democritus University of Thrace
- “Methods to Refine the Self-Localization of Planetary Rovers Using Orbital Imaging”
- Improve the global localization of Space Rovers
- Urge from previous ESA activities on localization and rover integration
- Real Data
- Multiple scenarios

ESA Network/Partnering Initiative

- Key features:
  - Extraction of commonly observed Regions of Interest (ROIs) on both orbital and rover imagery
  - Opportunistic approaches to refine the localization
  - Integration of multiple localization techniques:
    - Locally on the rover
    - Globally on Georeferenced images

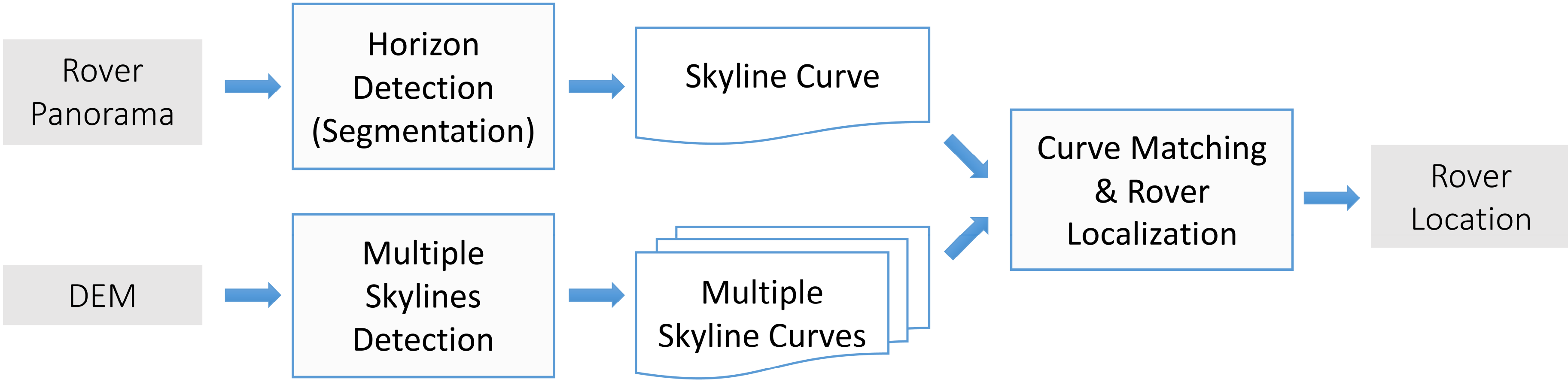
Descent Imagery

- Mapping and GIS Laboratory at OSU
- The flowchart of the approach:



Skyline

- The flowchart of the approach:



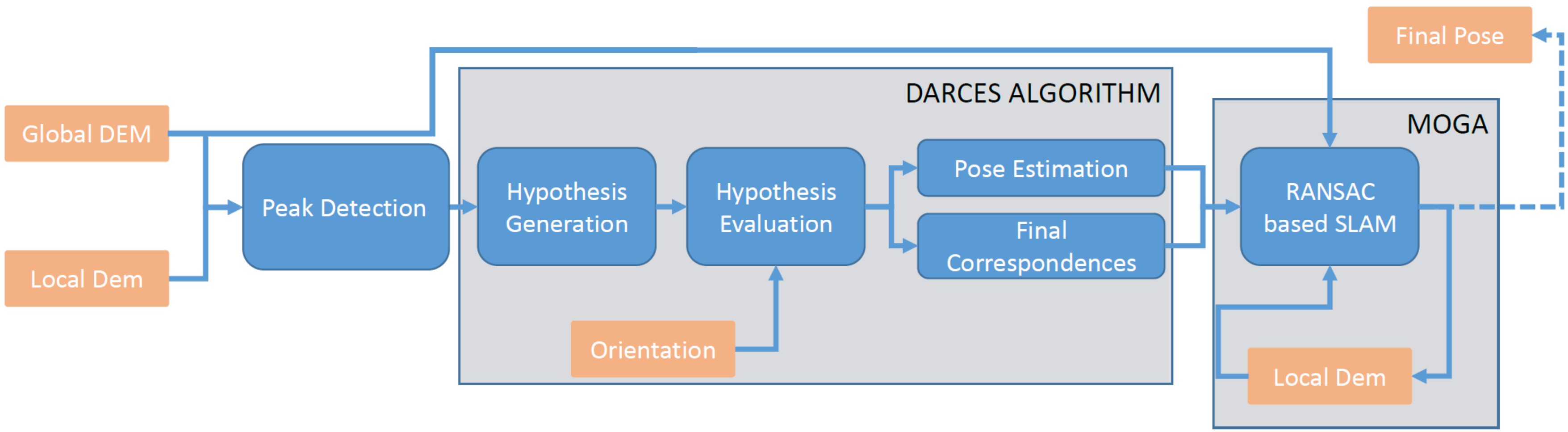
- **VI**sual **P**osition **E**stimation for **R**overs (**VIPER**). (Cozman and Krotkov)

- Explanatory animation follows:

Skyline

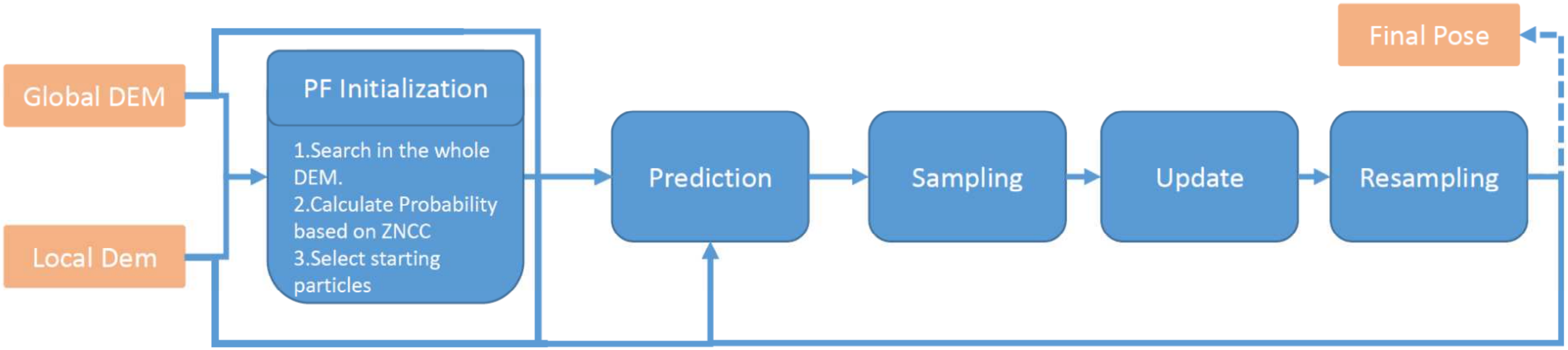
Skyline

- Autonomous Space Robotics Lab, Un. Toronto
- Long Range lidar scans instead of panoramas
- The flowchart of the approach:



Terrain Matching

- Matching of a local DEM to a global one
- Bayesian Recursive algorithm, Particle Filter

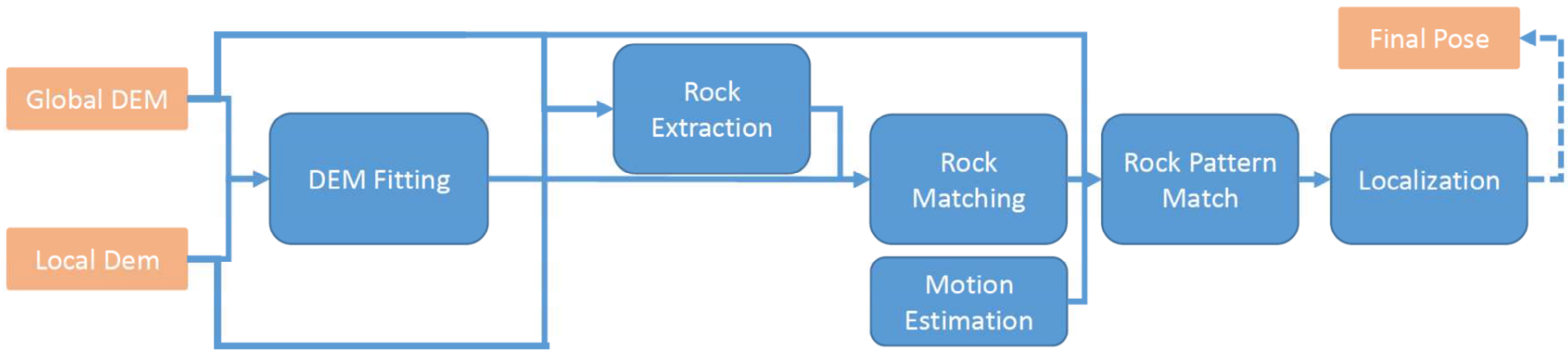


- Three main steps:
  - Prediction
  - Update
  - Resampling

Terrain Matching

Terrain Matching

- J.W. Hwankbo. Terrain matching and rock matching:



1. Fitting local and global DEMs (correlation)
2. SIFT Features to match rocks

Assessment Framework

- Key points:
  - Real World Relevance
  - Accuracy
  - Repeatability
  - Feasibility
  - Openness

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