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Belief Space Planning for Reducing Terrain Relative Localization Uncertainty in Noisy Elevation Maps

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Problem

- Today's planetary exploration rovers face problems of accurate global localization, since GPS doesn't exist

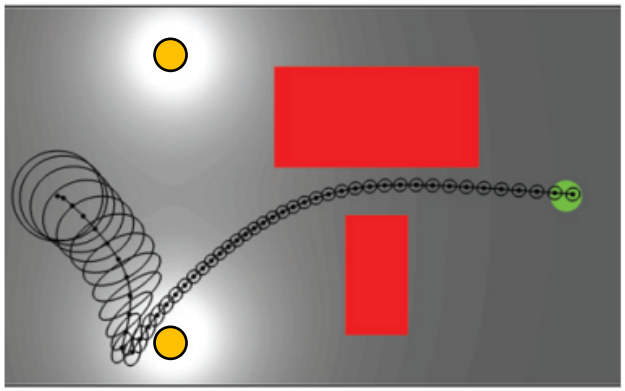
- Terrain relative navigation (TRN) achieves absolute positioning by correlating rover-perspective data to prior orbital data

- TRN accuracy is limited by:
  - Presence and uniqueness of terrain features
  - Quality of orbital data

Approach

- Decrease localization uncertainty by considering localization during the path planning process (belief space planning)

- Plan using multiple possible DEM samples to reduce errors in the DEM

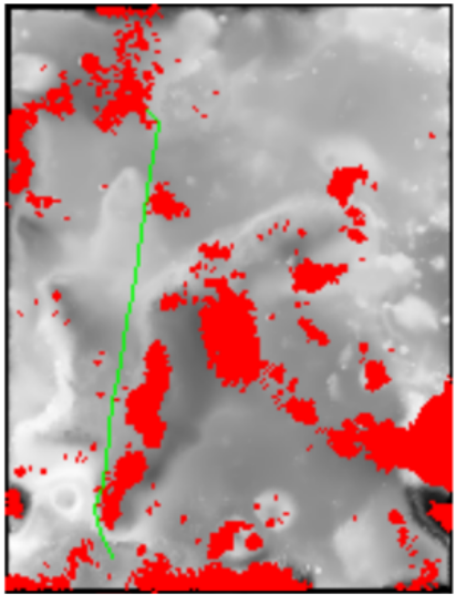


Belief space planned path deviates to area of higher certainty near beacons (orange) before heading towards the goal (green)

Image source: “Motion planning under uncertainty using iterative local optimization in belief space” (2012)

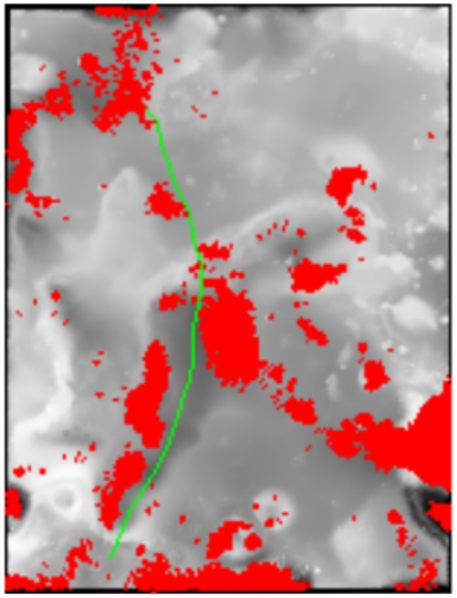
Results

Noise-free DEM
Shortest length path



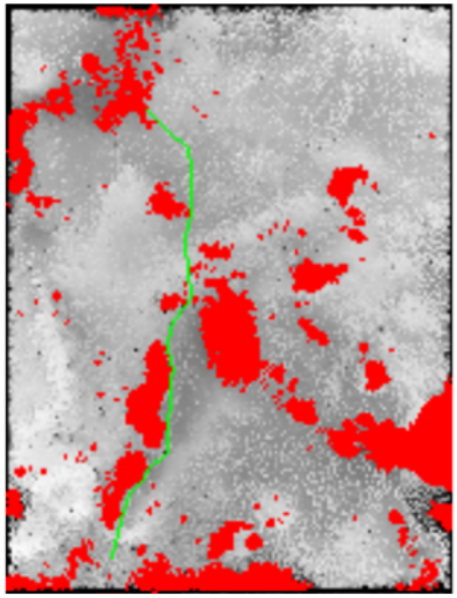
$tr(\sum_{goal}) = 225$
$pathLength = 158$

Noise-free DEM
Baseline BRM path



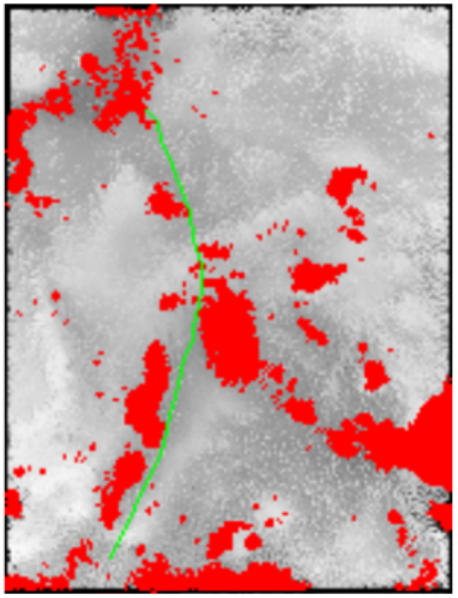
$tr(\sum_{goal}) = 184$
$pathLength = 164$

Noisy DEM
Baseline BRM path



$tr(\sum_{goal}) = 228$
$pathLength = 169$

Noisy DEM
BRM w/ noisy sampling



$tr(\sum_{goal}) = 212$
$pathLength = 163$