Prioritized Technology: Pinpoint Landing on Titan
EDL Architecture Trade Study

Technical Goal

- Modeling, simulation, and algorithm proof-of-concept testing to quantify potential cost/benefit of alternate approaches, as follows
- Model the expected delivery error and navigation state knowledge error at atmospheric entry for relevant mission architectures
- Conduct study of entry body geometry optimization to reduce drag, hence reach lower altitude with less dispersion, while maintaining adequate volume and aspect ratio for descent system/lander
- Extend prior algorithm development to evaluate feasibility, expected performance, and maximum operational altitude of TRN methods that match multi-modal imagery; develop new methods to recognize key terrain features onboard during descent (e.g. lakeshores, dunes). Potential to achieve position estimation error between 100 m and 5 km
- Given results of TRN study, assess expected control authority, controllability, and lander delivery error of alternate approaches to G&C, including entry guidance, parafoils, and propulsion

Mission Applications and Benefits

- All previous missions, studies, and proposals for Titan landers have used unguided EDL, which cannot provide small enough ellipses for future science objectives
- EDL architecture trade study will quantify expected cost/benefit for of improvements at every stage of EDL for reducing lander dispersions
- This will demonstrate (at TRL 3) the potential to land in Ontario Lacus (more diverse chemistry than the larger northern seas), near lakeshores and in dry lakebeds (likely evaporite deposits, coring, climate history), between sand dunes, and craters and putative cryovolcanic regions (potential contact between organics and water ice)
- Potential feedforward benefit to Venus precision landing and to navigation of low altitude Venus aerial platforms

Technical Status

- Since Huygens, there has only been one published Titan lander study (Titan Lake Probe study in 2010 for Decadal Survey)
  - Used ballistic entry and unguided parachute concept similar to Huygens; ellipse estimated to be about 200 km major axis
- There has been one published paper analyzing landing dispersions as a function of wind variations with season and latitude (Lorenz and Newman 2015)
  - Also assumed Huygens-like EDL. Estimated ellipses were on the order of 300 km
- One paper (Ansar and Matthies 2009) conducted limited proof-of-concept demonstration of ability to do onboard registration of VNIR descent imagery to orbital VNIR, infrared, or radar imagery to enable TRN despite the hazy atmosphere and low resolution orbiter imagery, which precludes direct application of TRN methods used for Mars

Development Cost and Schedule

5/26/17