Probability of Mobility for Mission Planning of Autonomous Ground Vehicles at “High Stress” Environments

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Motivation

- Current mobility models only consider the uncertainty in mobility prediction at specific locations, and have not investigated effects of mobility prediction uncertainty on mission planning
  - Uncertainty sources (vehicle design and terrain properties)
  - Correlation of soil properties over space
  - Mission mobility reliability
- The integration of off-road ground vehicle modeling and simulation (M&S) and vehicle online operation data has been rarely studied
  - Reliability updating (rare event can happen even for a high-reliability path)
  - Failure prediction (remaining mobile distance)

Fundamental Research Questions

- How to reduce the computational efforts while maintaining high accuracy in mission mobility reliability (MMR) analysis
- How to update the mission mobility reliability estimation during the mission when online mobility data are collected
- How to predict the remaining mobile distance of the vehicle to proactively prevent failures of immobility

Objectives

The objectives of 2020 research task (Task 2) are

1) to account for dependence of uncertainty sources in the mobility reliability prediction in mission planning
2) to reduce the computational cost of expensive MMR analysis
3) to develop a dynamic updating scheme to update the MMR estimation based on on-line mobility data, and avoid rare events of immobility during a mission

Approach

Probability of Mobility: \( \text{PoM} = \Pr\{M \leq r\} \)

Mission Mobility Reliability: \( R(\Omega) = \Pr\{V = G(X,Y(d)) \geq e, \forall d \in \Omega\} \)

Results

Future Work

- Perform MMR-based mission planning optimization.
- Route updating in during-mission phase