Simulating Localization in a Landmark Sparse Environment

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How can you find your location on a map? This is the problem that a technique called “localization” attempts to solve. In smartphone applications, a global positioning sensor (GPS) is used. For autonomous vehicles, a light detection and ranging (LIDAR) sensor is used instead. LIDAR has been successfully used for localization in indoor or dense urban environments. The goal of this project is to achieve localization with LIDAR in a very object sparse environment, like a field or an empty highway.

**System Overview**

There are two primary steps in our research using the data Paccar gathered from their truck at the test track:

1. Build a map.
2. Localize the truck within the map.

**Tools:**
- Robot Operating System (ROS)
- Python (programming language)
- Rviz (visualization software)

**Map Building**

- We used a technique called Hector Slam.
  - Uses LIDAR scan data to create a feature map.
  - Incorporates features from the track into the model
  - Open source ROS implementation

**Localization**

- We used an approach called “Adaptive Monte Carlo Localization (AMCL)”
  - Determine position and rotation (pose) within a known map by using sensor feedback.
  - Uses probabilistic guesses about future states (particles) and iteratively updates them based on sensors observations.
  - Our model uses LIDAR as the sensor feedback, and vehicle odometry to generate the motion model’s future states

**Results**

- Using Hector Slam, we were able to generate a map that resembles the actual Paccar test track.
  - Map reflected basic shape of track, which is the governed by the odometry of the truck

**Future Work**

- Collect a lot more track data to construct a more accurate map
  - More runs around track could more accurately capture the true features of the test track
- Utilize RGB camera data sensor fusion alongside traditional AMCL
  - There has been research done in localizing using RGB cameras
  - Combining those techniques with LIDAR-based techniques could yield localization results
- Supplement odometry data with GPS-gathered data
  - Theoretically GPS can be converted to odometry. GPS can be more accurate and provide better ground-truth localization.