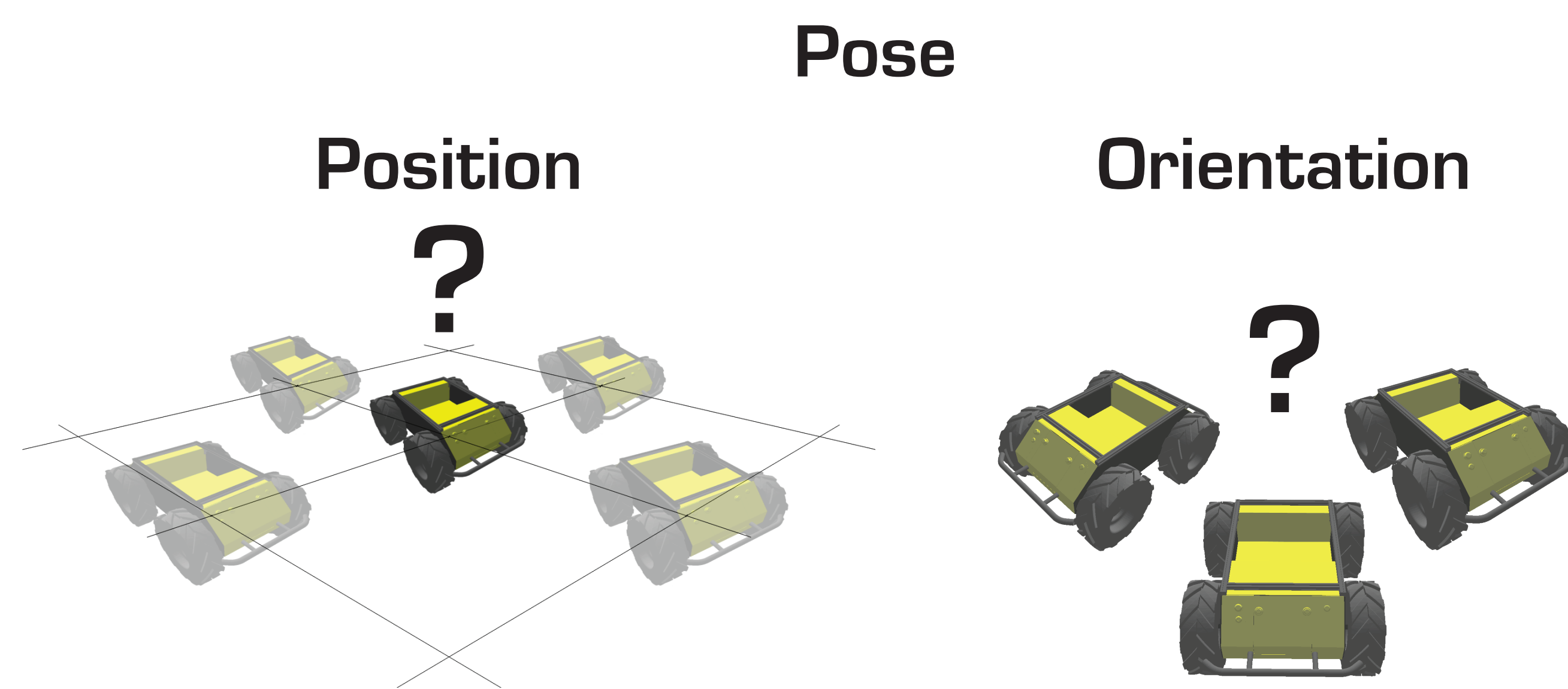# Mapping and Location: NASA Sample Return Robot Challenge

Team members: Caleb Gingrich, Daniel Johnson, Mohan Thomas
Supervisor: Professor Steven Waslander
Special thanks to the NSRRC team for robot and sensor simulation.
Special thanks to Professor Nüchter, Jacobs University.

Pose
Position **Orientation**
?   ?

Competition: Build a robot to autonomously explore extra-terrestrial terrain, collect samples of interest, and return to its starting location.

Team Goal: Using a laser range sensor, precisely locate the position of a robot in real time while constructing a map. This problem is known as Simultaneous Location and Mapping (SLAM). Only sensors functional in space are allowed (no GPS or compass).
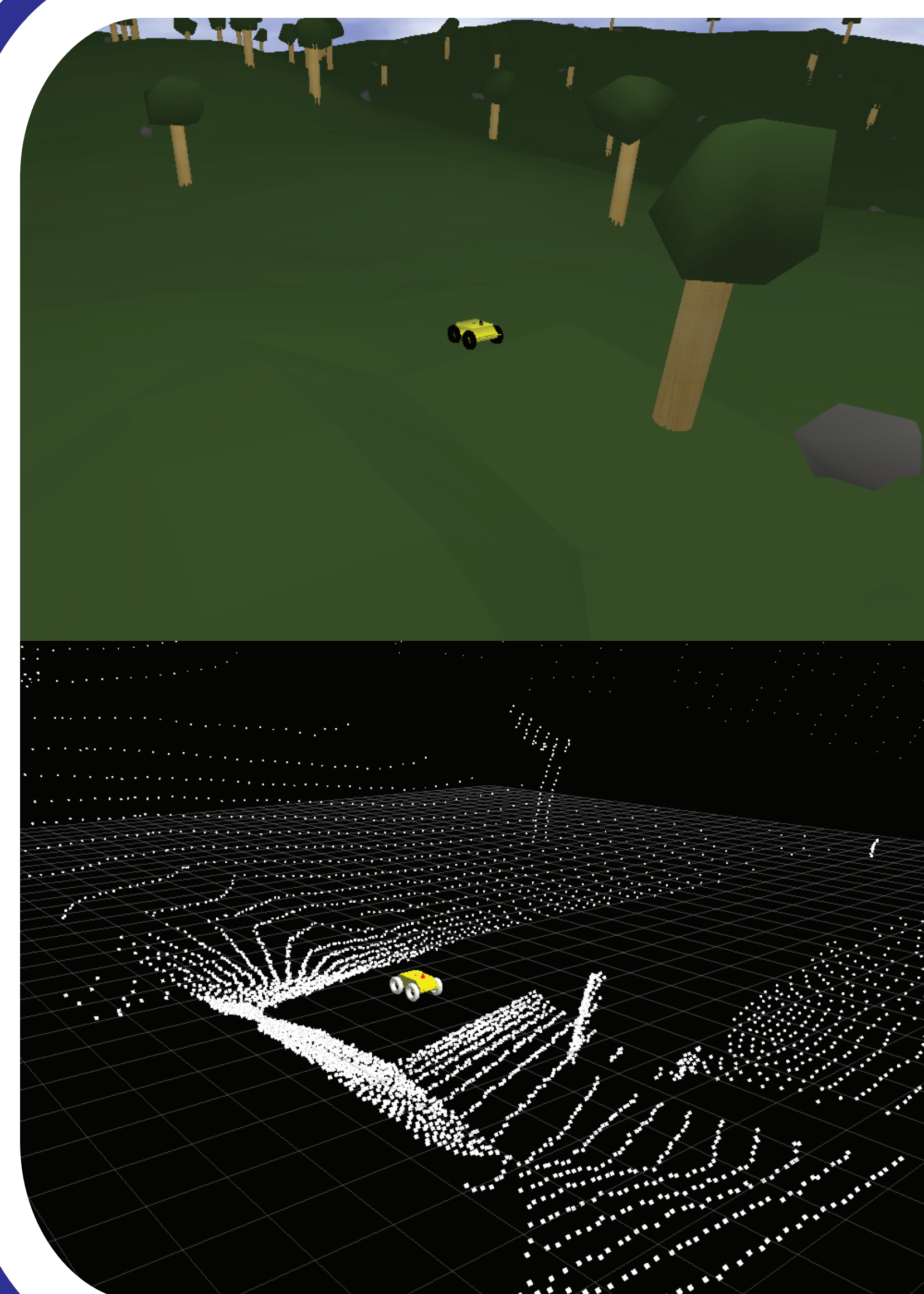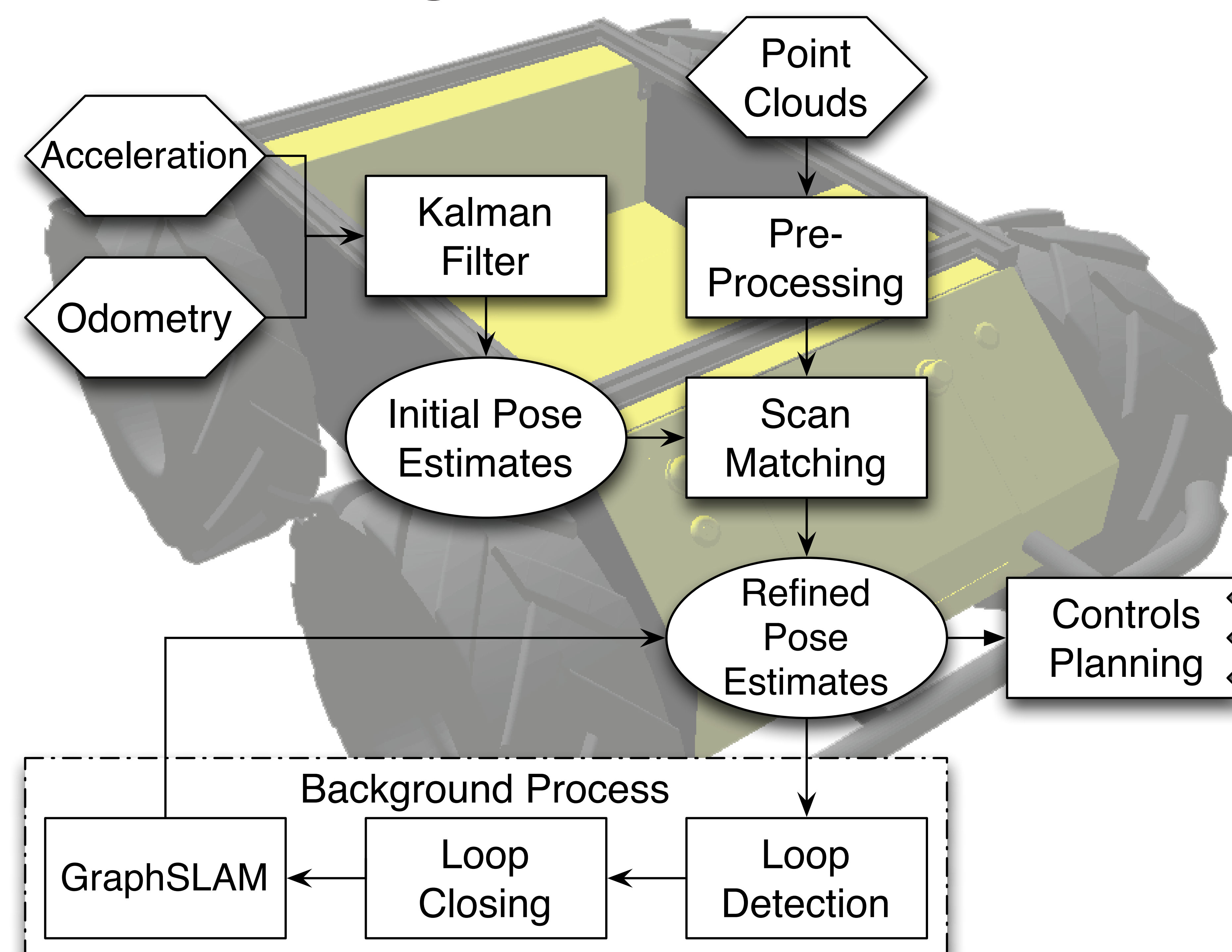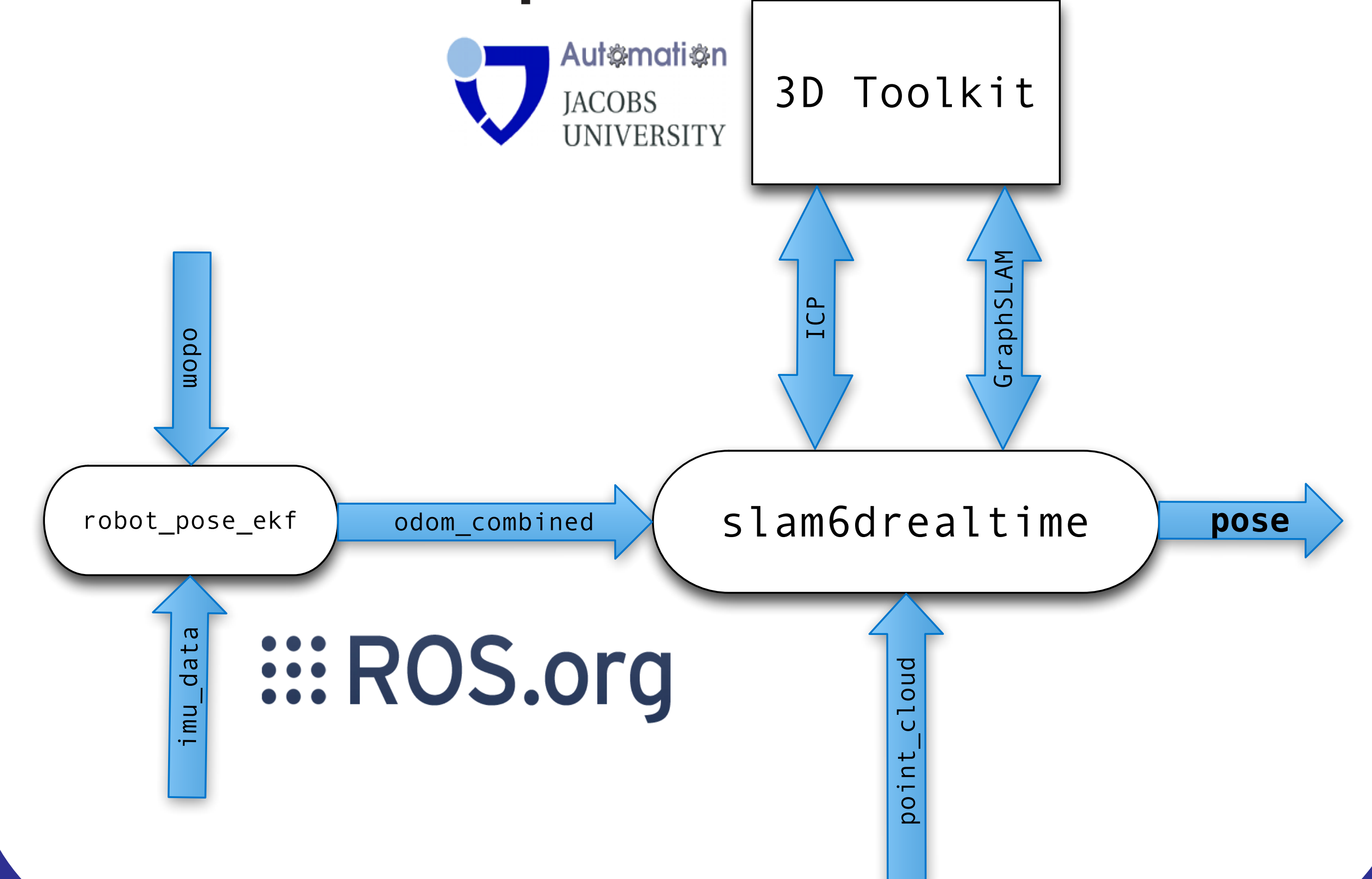
Inputs

A simulation environment was created to obtain point clouds from an outdoor environment.

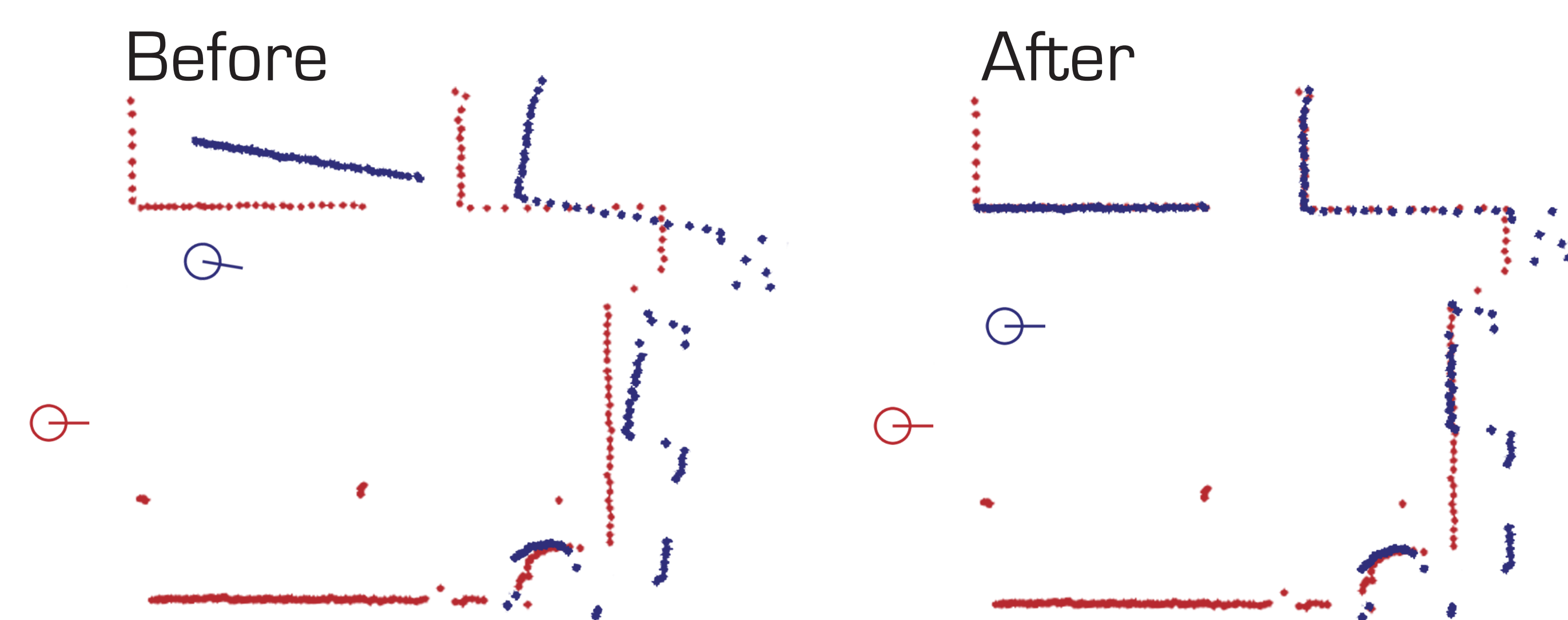Point clouds are 360° scans that measure the distance to the closest obstacle in many directions.

Algorithm Structure

- Acceleration
- Odometry
- Kalman Filter
- Initial Pose Estimates
- Point Clouds
- Pre-Processing
- Scan Matching
- Refined Pose Estimates
- Controls Planning

Background Process
- GraphSLAM ← Loop Closing ← Loop Detection

Implementation

Automation JACOBS UNIVERSITY

3D Toolkit

odom → robot_pose_ekf → odom_combined → slam6drealtime → pose

imu_data

ICP   GraphSLAM

point_cloud

ROS.org

Scan Matching: Iterative Closest Point

Before   After

The difference between the poses at which two scans were captured is estimated by minimizing the distance between corresponding points in the scans.

Global Error Redistribution: GraphSLAM

Before   After
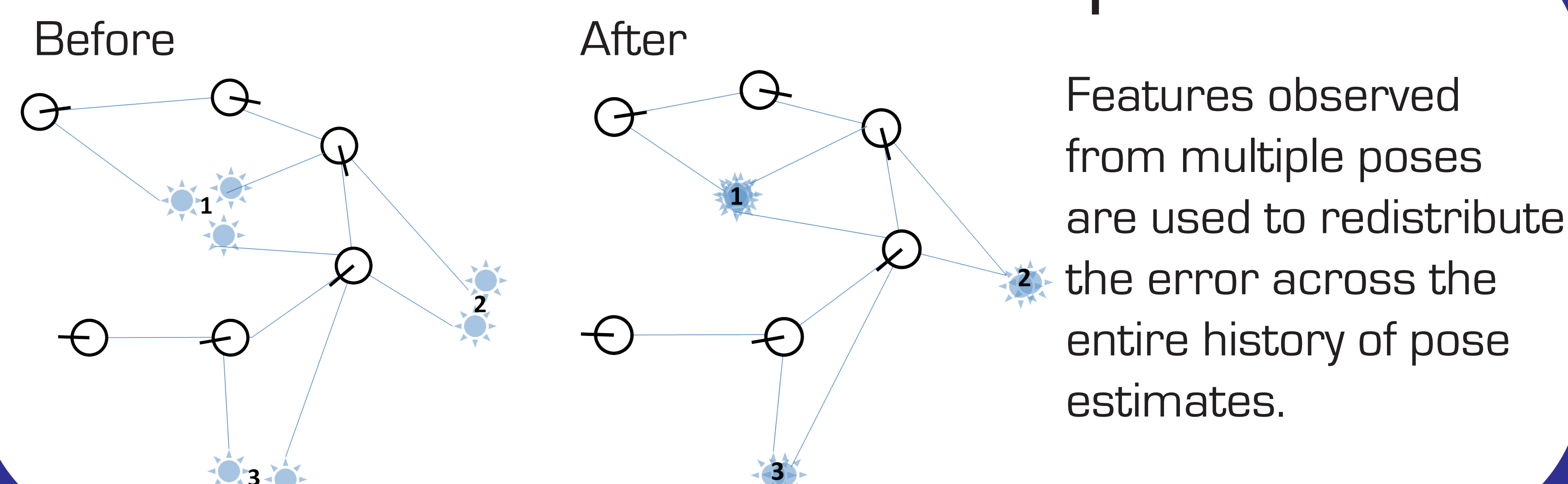
Features observed from multiple poses are used to redistribute the error across the entire history of pose estimates.

Results

— True Path   ◯ Initial Esitmate   ◯ Algorithm Estimate

radius is distance from estimate to true position