CS-8803 Special Topic: Machine Learning for Robotics

# Homework

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Office hours: 10:00 to 18:00.

## *Step 0: Setup*

For this homework, and many of the coming ones, a basic workspace will be made available in `/cs-share/pradalier/cs8804_students_ws`
In this case, we will be working onfinding the ground plane in a 3D point cloud. This point cloud is provided by the simulated kinect on the V-REP robot under the topic /vrep/depthSensor.

Important, from this homework, we will use a slightly more complex scene, `/cs-share/pradalier/scene/rosControlKinect3d.ttt`

Start by copying the floor_plane_hough and floor_plane_ransac ROS packages from the `cs8804_students_ws/src` directory. Make sure everything is working by compiling them with catkin_make.

The packages are fully configured to find the libraries they need. You don't need to touch the CmakeLists.txt or package.xml files. Just edit the `src/floor_plane_XXX.cpp` in each package. You should read the whole file to understand what's going on, but your contributions must be inserted between the "`TODO START`" tag and the "`END OF TODO`" tag.

## *Step 1: Model Finding using the Hough Transform*

For this step, you need to modify the `floor_plane_hough` package. The goal is to use the general principles of the Hough Transform to find likely plane parameters from the point cloud and in particular the ground plane. The Hough Transform relies on a nD accumulator. This is provided in the accumulator member variable, which is implemented as a 3D OpenCV matrix. Example of use are provided in the code.

The specific point of the linear-regression homework are still valid. Read the homework text again (step 1) to refresh your knowledge about the point clouds.

On the specific topic of the Hough Transform, here are a set of questions to consider:

- Why is the accumulator setup with 3 dimensions, what are the range and discretisation required for each dimension?
- Discretisation implies aliasing. Propose (but do not necessarily implement) a way to combing the Hough Transform with other tools to have a precise estimator while still being resilient to noise and outliers.

Evaluation:

- Evaluate the sensitivity of the plane estimation to environment parameters, in particular smooth slope transition and obstacles.
- Evaluate the computation load and find a good trade-off between precision and computation time by adapting the parameters.
- Do we need the same discretisation on all parameters?

## *Step 2: Model Finding using RANSAC*

For this step, you need to modify the `floor_plane_ransac` package. The goal is to use the general principles of RANSAC to find likely plane parameters from the point cloud and in particular the ground plane.

Evaluation:

- Find good parameters in terms of number of samples and tolerance. Try to find physical/mathematical justification for your choice of parameters.
- Evaluate the sensitivity of the plane estimation to environment parameters, in particular smooth slope transition and obstacles.
- Propose a solution to use RANSAC as a first step into a precise least-square-based ground plane detection.

## *Step 3: Deliverable*

Submit the ros packages (tar.gz or zip) by email by next Thursday, 10:00 to cedric.pradalier@georgiatech-metz.fr (don't forget to mention you group name)