

Sistemas de Tempo Real - 2024/2025

Practical Assignment No2

Mutual Exclusion, Process Synchronization, Measurement of Computation Times and ROS

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Instructions for installing ROS and running the submitted code can be found in `ros_workspace/README.md`

Practical Implementation details

Part I

Task 1:

The task was completed according to the instructions. A function was implemented that receives a file name and fills in a `lidar_data` structure, which contains a vector of a custom struct, `point3d`. The `point3d` struct stores three float values, one for each axis of 3D space.

Task 2:

- (a) Points behind the car were removed by filtering out all the points with negative x-axis value.
- (b) Two clusters of points in the car's forepart were also removed in step (a), as every point in these clusters had a negative x-axis value.
- (c) Points that were too far in front, to the side, or above the car were removed by filtering out points where the x, y, or z-axis values exceeded the thresholds specified by the user.

Task 3:

Filtered points were organized into a grid using the x and y axes to form columns of points. Within each column, the maximum and minimum z-axis values were determined. If the difference between the maximum and minimum z-axis values exceeded a predefined threshold, the corresponding column of points was removed from the drivable area.

The reasoning for this procedure is to exclude areas in the point cloud that the car cannot traverse due to large height differences. Such differences may indicate the presence of walls, doors, or other obstacles.

The final step of the function refines the point cloud by removing all points that exceed a predefined inclination. This ensures the exclusion of points associated with ceilings or

overhead objects. This step is not performed in Task 2 because removing higher points near the car earlier in the task would affect the accuracy of the column-based filtering system.

Task 4:

Task was completed according to instructions. The maximum total computation time recorded was **16.61 ms**.

Part II

Task 5:

The task was completed according to the instructions, utilizing two mutex structures and introducing a sleep period between processing point clouds.

Part III

Task 6:

The task was completed according to the instructions.

- **Thread 1:** Converts *PointCloud2* to *PointCloud* and extracts each point into the local *lidar_data* structure.
- **Thread 2:** Pre-processes the structure and hands it off to Thread 3.
- **Thread 3:** Identifies the drivable surface from the pre-processed data, converts the identified points into `geometry_msgs::Point32` type, and publishes the results.