CSC Point Cloud Workshop, February 8th 2022

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https://github.com/tuomasyr/Point-Cloud-Tools

Experiences in using Matlab and Puhti to process terrestrial laser scanning data

MATLAB as a tool to process point cloud data

- Efficient software to process point cloud data
- Point cloud processing-specific tools
  - pointCloud-object for storing and modifying 3D information (Computer vision toolbox)
  - Lidar toolbox (R2020b->)

Computer vision toolbox

Read and Write Point Clouds

pcread	Read 3-D point cloud from PLY or PCD file
pcwrite	Write 3-D point cloud to PLY or PCD file
pcfromkinect	Point cloud from Kinect for Windows
velodyneFileReader	Read point cloud data from Velodyne PCAP file

Store Point Clouds

pcviewset	Manage data for point cloud based visual odometry and SLAM
pointCloud	Object for storing 3-D point cloud

Visualize Point Clouds

pcshow	Plot 3-D point cloud
pcshowpair	Visualize difference between two point clouds
pcplayer	Visualize streaming 3-D point cloud data
showShape	Display shapes on image, video, or point cloud

Process Point Clouds

pcbin	Spatially bin point cloud points
pcdenoise	Remove noise from 3-D point cloud
pcdownsample	Downsample a 3-D point cloud
pcnormals	Estimate normals for point cloud
findPointsInROI	Find points within a region of interest in the point cloud
findNearestNeighbors	Find nearest neighbors of a point in point cloud
findNeighborsInRadius	Find neighbors within a radius of a point in the point cloud
removeInvalidPoints	Remove invalid points from point cloud

Segment Point Clouds

pcsegdist	Segment point cloud into clusters based on Euclidean distance
segmentGroundFromLidarData	Segment ground points from organized lidar data
segmentLidarData	Segment organized 3-D range data into clusters

Lidar toolbox

I/O

lasFileReader	LAS or LAZ file reader
ibeoLidarReader	Ibeo data container (IDC) file reader

Preprocessing

pcmedian	Median filtering 3-D point cloud data
pcorganize	Convert 3-D point cloud into organized point cloud
lidarParameters	Lidar sensor parameters
pc2dem	Create digital elevation model (DEM) of point cloud data
extractEigenFeatures	Extract eigenvalue-based features from point cloud segments
extractFPFHFeatures	Extract fast point feature histogram (FPFH) descriptors from point cloud
detectRectangularPlanePoints	Detect rectangular plane of specified dimensions in point cloud

Labeling, Segmentation, and Detection

Labeling

Use Lidar Labels

groundTruthLidar	Lidar ground truth label data
selectLabels	Select ground truth data by label name or type
selectLabelsByGroup	Select ground truth data by label group name
selectLabelsByName	Select ground truth data by label name
selectLabelsByType	Select ground truth data by label type
changeFilePaths	Change file paths in ground truth data

Create Label Definitions

labelDefinitionCreatorLidar	Store, modify, and create label definitions tables for lidar
addAttribute	Add attribute to label in label definition creator for lidar workflow
addLabel	Add label to label definition creator object for lidar workflow
create	Create label definitions table from label definition creator object for lidar workflow
editAttributeDescription	Modify attribute description in label definition creator object for lidar workflow
editGroupName	Change group name in label definition creator for lidar workflow
editLabelDescription	Modify label description in label definition creator for lidar workflow
editLabelGroup	Modify label group name in label definition creator object for lidar workflow
info	Display label or attribute information stored in label definition creator for lidar workflow
removeAttribute	Remove attribute from label in label definition creator for lidar workflow
removeLabel	Remove label from label definition creator for lidar workflow

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MATLAB as a tool to process point cloud data

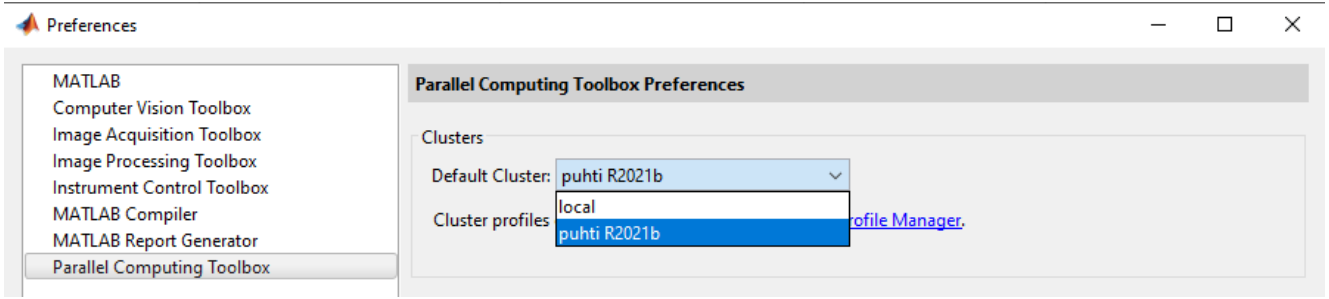
- Efficient software to process point cloud data
- Point cloud processing-specific tools
  - pointCloud-object for storing 3D information (Computer Vision toolbox)
  - Lidar toolbox (R2020b->)
- LAStools integration (execute system commands)

```
% ------------------------------------------------------------------------
% example: lastools('lasinfo -i pointcloud.las')
% ------------------------------------------------------------------------
function lastools(las_string)
    ld = 'C:/Users/yrtti/LAStools/bin/';
    command = [ld,las_string];
    system(command);
end
```

- Licensing can be a problem for non-academic users

Puhti as a platform for point cloud processing

- The web interface enables easy access and use of data
- Benefits in co-operation between users working with the same data
- Increased computing performance in multi-core processing
- Batch jobs can be submitted to Puhti from your local Matlab GUI
  - https://docs.csc.fi/apps/matlab/



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```
% Add to path the Matlab Parallel Server scripts
addpath(genpath('C:/Program Files/MATLAB/csc_r2021'))

% Configure parallel computing cluster
configCluster

% Define cluster parameters
c = parcluster;
c.AdditionalProperties.WallTime = '3:00:0';
c.AdditionalProperties.MemUsage = '64g';
c.AdditionalProperties.QueueName = 'small';
c.AdditionalProperties.AccountName = 'project_200XXXX';
c.AdditionalProperties.EmailAddress = 'tuomas.yrttimaa@uef.fi';

% Check configured values
c.AdditionalProperties
c.saveProfile

% Submit a batch job defined in script.m
j = batch(c, @script, 1, {},'Pool',20,'CurrentFolder', '.', 'AutoAddClientPath', false)

% See the output
out = j.fetchOutputs;
```


Thank you!