Simultaneous Localization and Mapping (SLAM) using Iterative Closest Point (ICP)

Autonomous Robots Labs

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Exploring Unknown Environment $\Rightarrow$ SLAM

- Build map of the environment
- Localize the robot within map

$\Rightarrow$ Simultaneous Localization and Mapping (SLAM)

Examples

- 2D lidar + IMU, indoor (Hector)
- Stereo, outdoor (RTAB-Map)
- 3D lidar, indoor (BLAM)
- 3D lidar, outdoor with dynamic obstacles (ICP Mapper)

2D ICP SLAM: Overview

- Align lidar scans to a point map if any, using iterative closest points (ICP)
  - ! Your homework: implement `aro_slam.icp` module in the template
- Update point map from aligned point clouds
- Update grid occupancy for exploration and planning
  - Distinguishes {unknown, empty, . . . , occupied} cell states
- Lecture slides on ICP
- Lecture slides on absolute orientation

ROS in Singularity Container

- At classrooms E-130, E-132
- Remotely at GPU server

```
ssh -X username@cantor.felk.cvut.cz
ssh -X username@taylor.felk.cvut.cz
```

  ! Currently no graphical output within Singularity

```
$ singularity shell --nv /opt/ros-kinetic-desktop-full.simg
```

Empty Catkin Workspace (1)

- Mind the workspace you extend
- Enable optimization for C++ packages
  - `Debug` makes debugging C++ easier

```
mkdir -p ~/workspace/aro/src
cd ~/workspace/aro
catkin init
catkin config --extend /opt/ros/kinetic
catkin config --cmake-args -DCMAKE_BUILD_TYPE=RelWithDebInfo
catkin build
```

Empty Catkin Workspace (2)

```
Singularity ros-kinetic-desktop-full.simg:~/workspace/aro> catkin config
----------------------------------------------------------------------
Profile:                     default
Extending:         [explicit] /opt/ros/kinetic
Workspace:                   /home.nfs/petrito1/workspace/aro
----------------------------------------------------------------------
Source Space:       [exists] /home.nfs/petrito1/workspace/aro/src
Log Space:          [exists] /home.nfs/petrito1/workspace/aro/logs
Build Space:        [exists] /home.nfs/petrito1/workspace/aro/build
Devel Space:        [exists] /home.nfs/petrito1/workspace/aro/devel
Install Space:      [unused] /home.nfs/petrito1/workspace/aro/install
DESTDIR:            [unused] None
----------------------------------------------------------------------
Devel Space Layout:          linked
Install Space Layout:        None
----------------------------------------------------------------------
Additional CMake Args:       -DCMAKE_BUILD_TYPE=RelWithDebInfo
Additional Make Args:        None
Additional catkin Make Args: None
Internal Make Job Server:    True
Cache Job Environments:      False
----------------------------------------------------------------------
Whitelisted Packages:        None
Blacklisted Packages:        None
----------------------------------------------------------------------
Workspace configuration appears valid.
----------------------------------------------------------------------
```

Empty Catkin Workspace (3)

```
Singularity ros-kinetic-desktop-full.simg:~/workspace/aro> catkin build

Extending:         [explicit] /opt/ros/kinetic

Source Space:        [exists] /home.nfs/petrito1/workspace/aro/src
Log Space:           [exists] /home.nfs/petrito1/workspace/aro/logs
Build Space:         [exists] /home.nfs/petrito1/workspace/aro/build
Devel Space:         [exists] /home.nfs/petrito1/workspace/aro/devel
Install Space:       [unused] /home.nfs/petrito1/workspace/aro/install

Additional CMake Args:        -DCMAKE_BUILD_TYPE=RelWithDebInfo

Workspace configuration appears valid.

[build] Summary: All 0 packages succeeded!
```

(Showing excerpts...)

Catkin Workspace: ICP SLAM

```
cd ~/workspace/aro/src
curl -O https://cw.fel.cvut.cz/b182/_media/courses/aro/tutorials/icp_slam.zip
unzip icp_slam_student.zip
catkin build
```

```
source ~/workspace/aro/devel/setup.bash
roslaunch aro_slam bag.launch
```