

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
 - ▶ Namely the `icp` function in `aro_slam/src/aro_slam/icp.py`
- ▶ 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:

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

- ▶ Remotely at GPU server:

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

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

! Currently no graphical output within Singularity

- ▶ On your computer: install dependencies from the [Singularity recipe](#)

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 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.zip
catkin build
```

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

Without odometry:

```
roslaunch aro_slam bag.launch with_odom:=false
```