FOSDEM

I'm giving a talk:

WHALES USE LIGHTHOUSES TOO: OPEN SOURCE POSITIONING FOR OPEN SOURCE

2nd February, 2025

Robotics and Simulation devroom, UB2.147

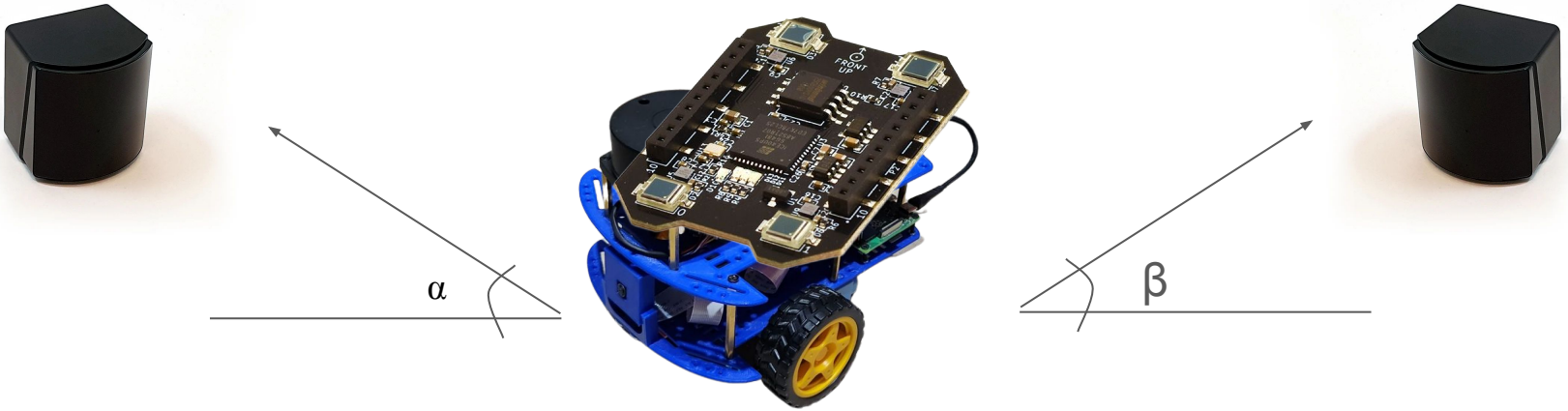
fosdem.org/2025/schedule/track/robotics/

EKUMEN

BELUGA

Gerardo Puga, Gonzalo de Pedro, Juan Manuel Carosella, Michel Hidalgo

Lighthouse Positioning system



Lighthouse positioning deck: timing info from the base stations scans.

Lighthouse_ros: Computes azimuth and elevation angles to the base stations.

Enter Beluga

Open source Monte Carlo Localization (MCL) toolkit, focused on code quality and performance.

- AMCL drop-in replacement node
  - ROS1 and ROS2 support
- Extensible, ROS independent, MCL library.

Beluga as a library

```
1.    auto update(state_type control_action, measurement_type measurement) -> estimation_type {
2.      particles_ |= beluga::actions:: propagate(motion_model_ (window << std:: move(action))) |
3.                    beluga::actions:: reweight(sensor_model_ (std::move(measurement)))       |
4.                    beluga::actions:: normalize();
5.
6.      particles_ |= beluga::views::sample                    |
7.                    beluga::views:: take_while_kld(params) |
8.                    beluga::actions::assign;
9.
10.     return beluga::estimate(beluga::views:: states(particles_),
    beluga::views:: weights(particles_));
11.   }
```

Two ways to adapt Beluga to our needs:

- Write a new `sensor_model`, and use Beluga AMCL algorithm.
- Make a new `update` method, using the lower level APIs.
  - Maybe if we want to fuse lidar and lighthouse

Beluga as a library

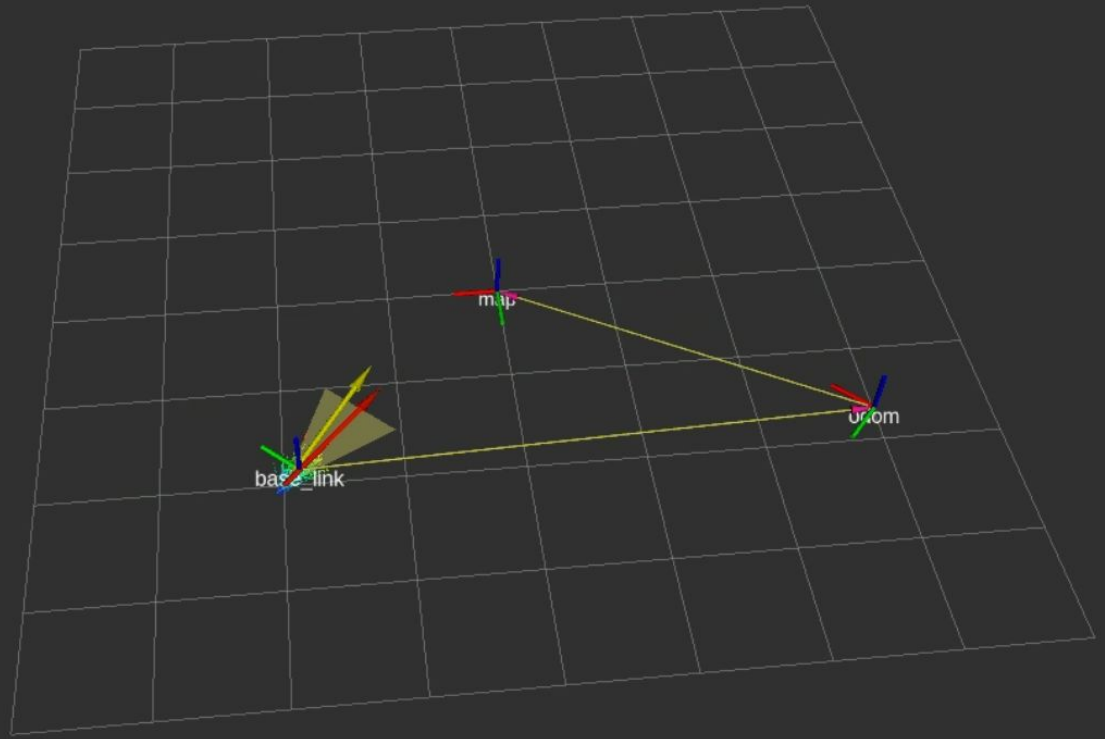
- Write `LightHouseSensorModel2D`

```
1.  LightHouseSensorModel2D (param_type params, LighthouseStationMapType landmark_map) {}
2.
3.  /// Returns a state weighting function conditioned on lighthouse deck
4.  /// measurements
5.  auto operator()(measurement_type &&detections)  const {
6.   return [this, detections = std::move(detections)](const state_type &state) -> weight_type
7.   {
8.     (...)
9.     return direction_error_prob;
10.  };
11.  }
```

- Write lighthouse_amcl ROS node wrapping Beluga AMCL:
  - Subscribes to the sensor messages
  - Runs MCL particle filter using the lighthouse sensor model

```
beluga::Amcl(MotionModel motion_model, SensorModel sensor_model,  const AmclParams& params)
```

Beluga updating robot pose using simulated lighthouse base station positions



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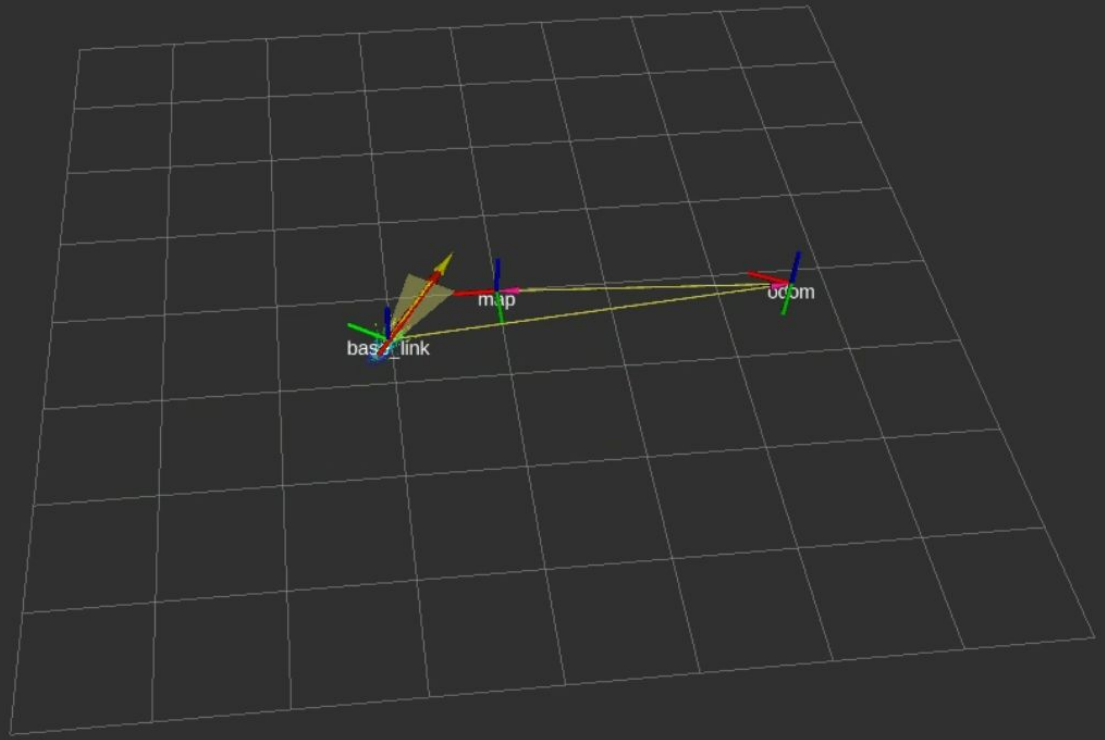

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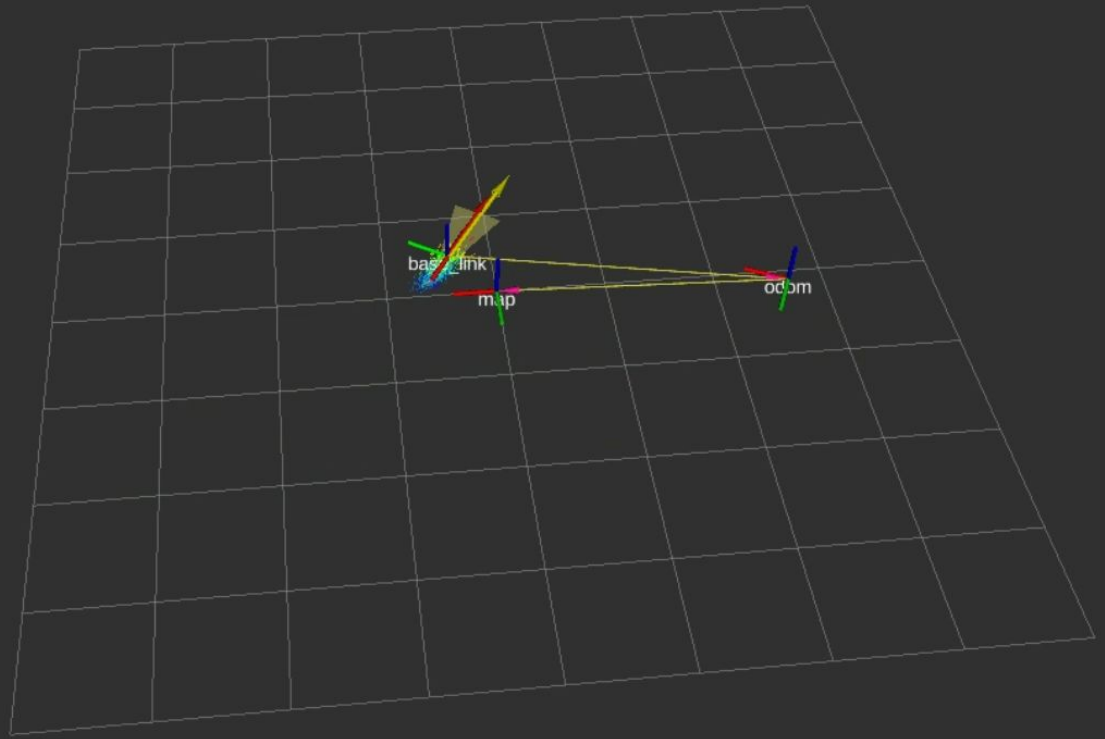

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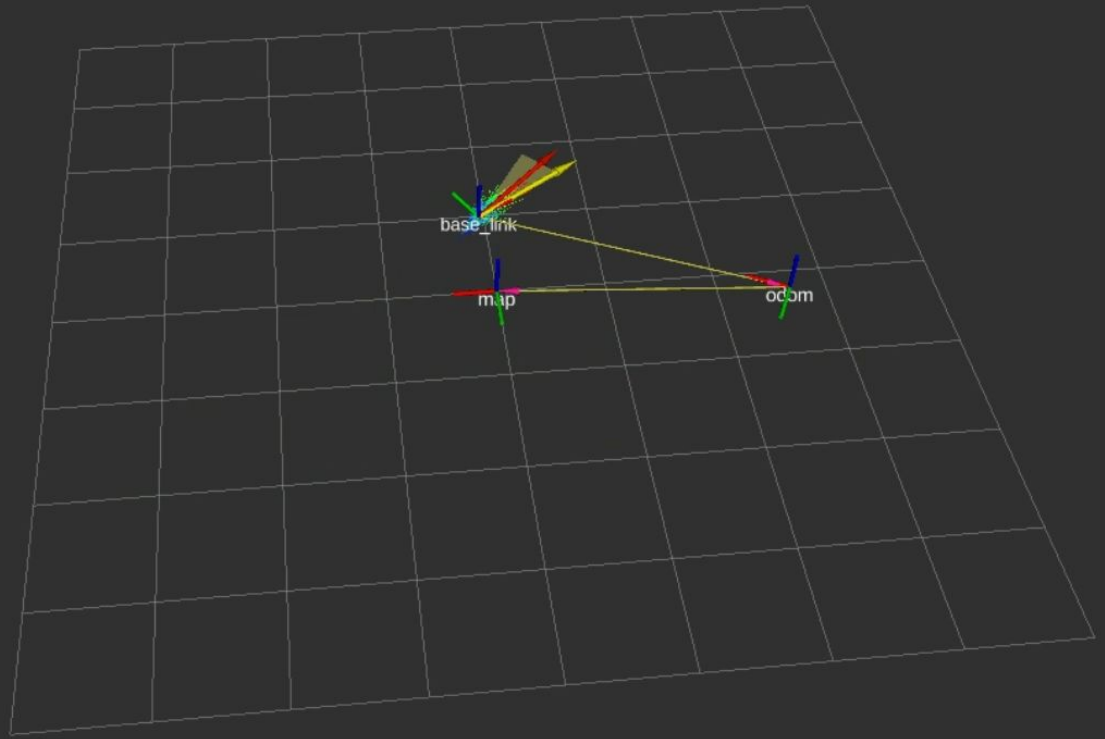

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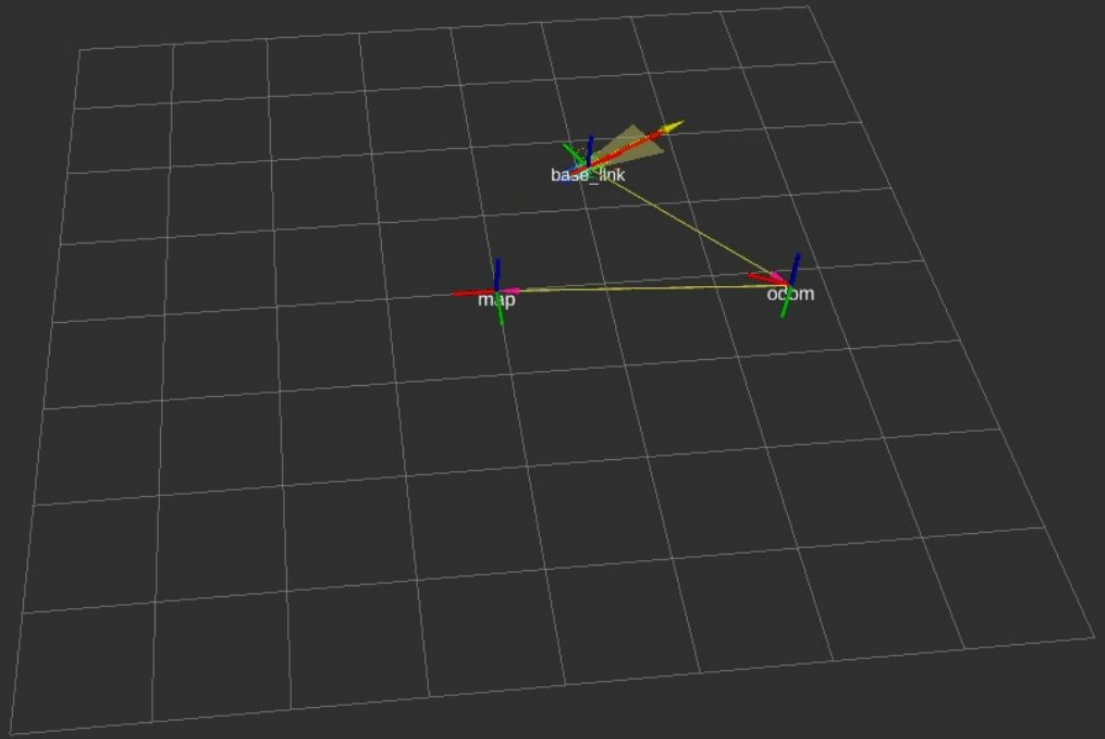

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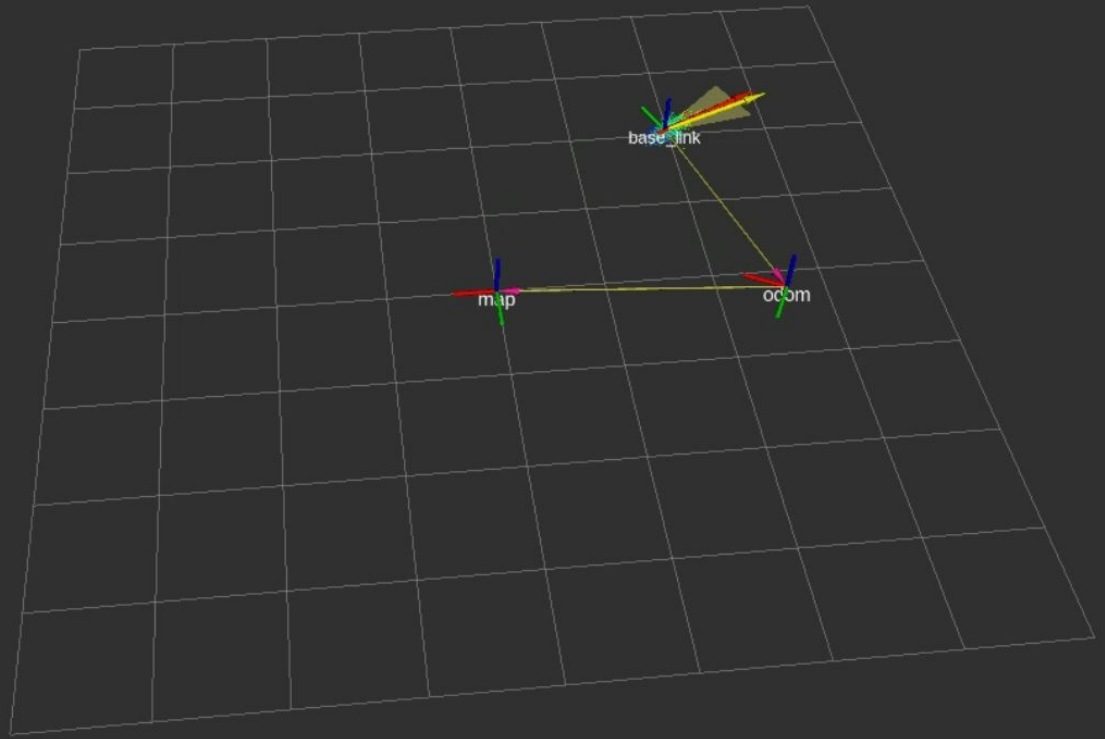

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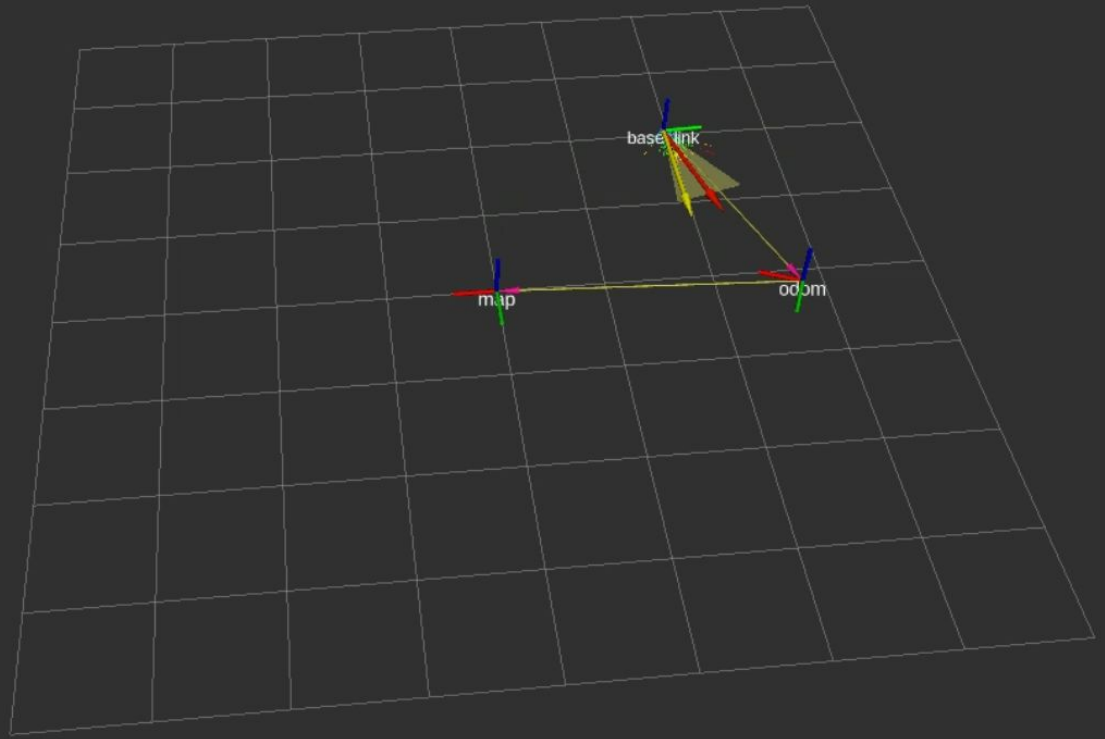

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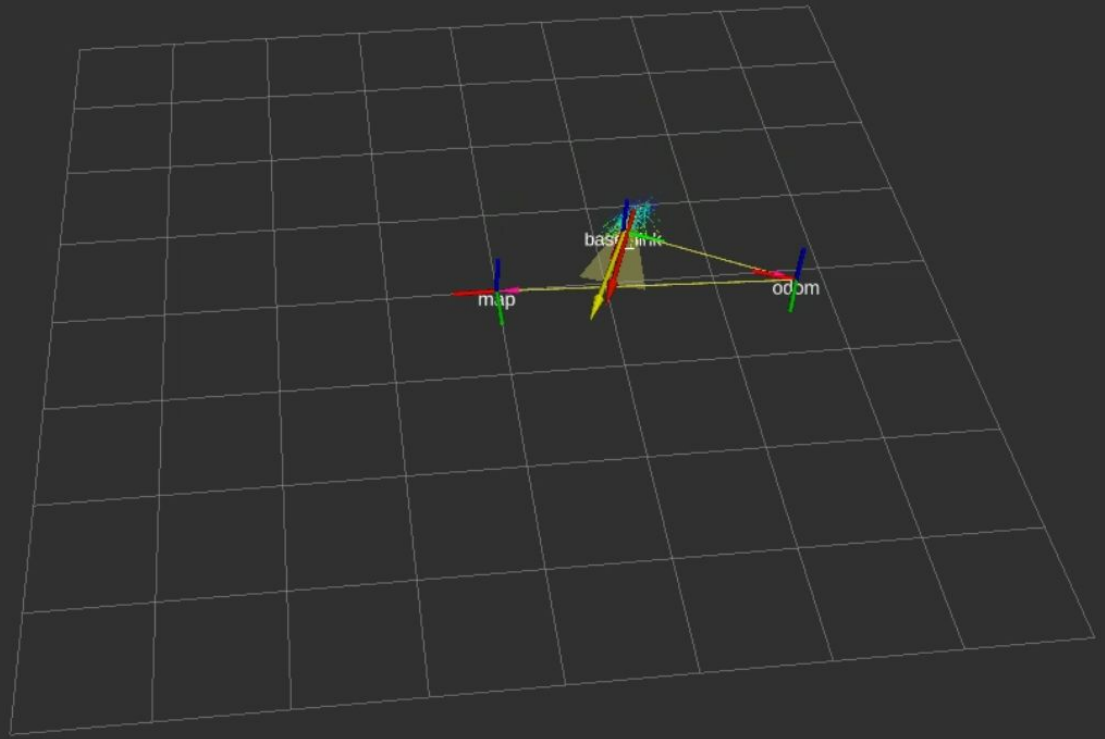

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Thank you!