**Localization Sensor Fusion Library**

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| **Sensors**   * Encoder * IMU * GPS * Camera * Lidar | **Odometries**   * Encoder Odometry * IMU Odometry * GPS Odometry * Visual Odometry * Lidar Odometry |

**Input / Output Data Types (as IDL)**

* [nav\_msgs/Odometry](http://docs.ros.org/api/nav_msgs/html/msg/Odometry.html)
* [sensor\_msgs/Imu](http://docs.ros.org/api/sensor_msgs/html/msg/Imu.html)
* [geometry\_msgs/PoseWithCovarianceStamped](http://docs.ros.org/api/geometry_msgs/html/msg/PoseWithCovarianceStamped.html)

**Fusion Algorithm**

* Extended Kalman Filter
* Unscented Kalman Filter
* … more can be added if needed

**Relevant Links**

* Robot Localization Package
  + <https://github.com/cra-ros-pkg/robot_localization>
  + <https://github.com/methylDragon/ros-sensor-fusion-tutorial/>
* Generic Sensor Fusion Package
  + <https://github.com/tuw-cpsg/sf-pkg>
* Robot Pose EKF Package
  + <https://github.com/udacity/robot_pose_ekf>
* Error-State Kalman Filter Package
  + <https://github.com/EliaTarasov/ESKF>
* Python Robotics Localization Guide
  + <https://pythonrobotics.readthedocs.io/en/latest/modules/localization.html>

**Preliminary Plan (4-months)**

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| **Phases & Tasks** | | **Week 1** | **Week 2** | **Week 3** | **Week 4** | **Week 5** | **Week 6** | **Week 7** | **Week 8** | **Week 9** | **Week 10** | **Week 11** | **Week 12** | **Week 13** | **Week 14** | **Week 15** | **Week 16** | **Week 17** | **Week 18** |
| 1. **Related Work Review** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Checking available implementations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Checking previous publications |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Report the outcomes with justifications |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. **Initial Library Pipeline** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Selecting one input and output datatypes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Selecting one fusion algorithm |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Implementing initial library pipeline |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Testing the pipeline over a dataset |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Report the outcomes with discussions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Generate a README / documentation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. **Update Library Pipeline** | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Allow various input / output datatypes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Allow various fusion algorithms |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Implementing updated library pipeline |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Testing the pipeline over a dataset |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Report the outcomes with discussions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Update a README / documentation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Tasks Descriptions**

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**1.a) Checking available implementations**

There are few packages available online, which worth checking as first step before proceeding with implementation, as a sense of inspiration and possible citation.

**1.b) Checking previous publications**

Not all published work has open-source packages, accordingly, checking publication over the last 5-years in the topic would give a better understanding of the problem, the current advances and a guide on where to go.

**1.c)Report the outcomes with justifications**

Deliverable report on the outcomes of the previous steps, with justifications of the decisions to be made for the next steps.

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**2.a) Selecting one input and output datatypes**

Recommendation to start with PoseWithCovarianceStamped as the initial datatype for both inputs and output, however, if there is a proper justification for another choice, it will be welcomed and appreciated. Any selection should be decoded to an internal format, for the ease of modularity in the future.

**2.b) Selecting one fusion algorithm**

Recommendation to start with Extended Kalman Filter as the fusion algorithm, however, if there is a proper justification for another choice, it will be welcomed and appreciated. Any selection should be implemented using template classes, for the ease of modularity in the future.

**2.c)Implementing initial library pipeline**

Deliverable package with the implementation of the selected algorithm to fuse localizations with selected datatypes.

**2.d) Testing the pipeline over a dataset**

Testing must be done over a dataset with reference localization.

**2.e)Report the outcomes with discussions**

Based on selected evaluation metrics, the obtained results are compared to the reference one, in addition to discussion / comments on the behavior as validation to the initial hypothesis that fusion leads to better outcome, and in case of otherwise, justification is required.

**2.f)Generate a README / documentation**

Writing a full README for the package with documentation on how to use

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**3.a) Allow various input / output datatypes**

Through a configuration file, allow the possibility for more datatypes for the inputs and outputs, which should be decoded to the same internal format.

**3.b) Allow various fusion algorithms**

Through a configuration file, allow the possibility for more algorithms for the fusion, which should be using the same template classes.

**3.c)Implementing updated library pipeline**

Deliverable update of the package with the implementation of the extension of various algorithms to fuse localizations with various datatypes.

**3.d) Testing the pipeline over a dataset**

Testing must be done over the same dataset with reference localization.

**3.e)Report the outcomes with discussions**

Updated the report with the findings based on the same evaluation metrics

**3.f)Update a README / documentation**

Update the README for the package with documentation on how to use.