4th MIDTERM HOMEWORK

TORO - Tree-based netwORk Optimizer

- TORO is an optimization approach for constraint-network. It provides a highly efficient, **gradient descent-based error minimization procedure.**
- In 2006, Olson et al. presented a novel approach to solve the graph-based SLAM problem by applying stochastic gradient descent to minimize the error introduced by constraints.
- TORO is an extension of Olson's algorithm. It applies a tree parameterization of the nodes in the graph that significantly improves the performance and enables a robot to cope with arbitrary network topologies. The latter allows us to bound the complexity of the algorithm to the size of the mapped area and not to the length of the trajectory.

TORO - Tree-based netwORk Optimizer

The source code is available via svn:
https://www.openslam.org/data/svn/toro

http://www2.informatik.uni-freiburg.de/~stachnis/toro/

The software is written in C++ (GNU C++ compiler, developed under Linux) and requires no additional libraries or has any other dependency than the standard template library.

Logfile Format

A set of simple text messages to represent nodes and edges of the graph. Note that examples files are in the repository, see folder data.

Format of the 2D graph files: Every line in the file specifies either one vertex or one edge

The vertices are specified as follws: VERTEX2 id x y orientation (A 2D node in the graph)

EDGE2 observed_vertex_id observing_vertex_id forward sideward rotate inf_ff inf_fs inf_ss inf_rr inf_fr inf_sr (A 2D-edge in the graph. inf_xx are the information matrix entries of the constraint)

EQUIV id1 id2 (Equivalence constraints between nodes. It merges the node id1 and id2 wrt to the constraint between both vertices.)

Format of the 3D graph files: Every line in the file specifies either one vertex or one edge

The vertices are specified as follws: VETREX3 x y z phi theta psi

The edges are specified as follows: EDGE3 observed_vertex_id observing_vertex_id x y z roll pitch yaw inf_11 inf_12 .. inf_16 inf_22 .. inf_66 (the information matrix is specified via its upper triangular block that means 21 values).

TORO

- Format of the 2D graph files: Every line in the file specifies either one vertex or one edge The vertices are specified as follws: VERTEX2 id x y orientation (A 2D node in the graph) EDGE2 observed_vertex_id observing_vertex_id forward sideward rotate inf_ff inf_fs inf_ss inf_rr inf_fr inf_sr (A 2D-edge in the graph. inf_xx are the information matrix entries of the constraint) EQUIV id1 id2 (Equivalence constraints between nodes. It merges the node id1 and id2 wrt to the constraint between both vertices.)

g2o: A General Framework for Graph Optimization

- A wide range of problems in robotics as well as in computer-vision involve the minimization of a non-linear error function that can be represented as a graph. Typical instances are simultaneous localization and mapping (SLAM) or bundle adjustment (BA). The overall goal in these problems is to find the configuration of parameters or state variables that maximally explain a set of measurements affected by Gaussian noise. g2o is an open-source C++ framework for such nonlinear least squares problems. g2o has been designed to be easily extensible to a wide range of problems and a new problem typically can be specified in a few lines of code. The current implementation provides solutions to several variants of SLAM. g2o offers a performance comparable to implementations of state-of-the-art approaches for the specific problems (02/2011).

g2o: A General Framework for Graph Optimization

Input Data
Nodes and edges of a graph.

Logfile Format
A set of simple text messages to represent nodes and edges of the graph.
Note that examples files are in the repository. See folder data.

Type of Map
Graphs (nodes and edge)

iSAM: Incremental Smoothing and Mapping

- For most real robotics applications the estimates need to be available online to be useful for navigation, planning or manipulation. While the SLAM literature often focuses on batch processing of recorded datasets, iSAM instead focuses on online operation, providing the best estimate available at any time while keeping the computational requirements low.
- iSAM has successfully been used online on a range of mobile robot platforms, including ground robots (DARPA LAGR platform, Willow Garage PR2), aerial robots (quadrotors), and underwater robots (Bluefin HAUV, Hydroid REMUS 100).

iSAM: Incremental Smoothing and Mapping

- The latest version of iSAM is available at http://people.csail.mit.edu/kaess/isam

- https://svn.csail.mit.edu/isam/

Karto Mapping

This mapping library contains a scan matcher, pose graph, loop detection, and occupancy grid construction -- all important building blocks for 2D navigation. When combined with Willow Garage's Sparse Pose Adjustment (SPA) for optimization (in the sba ROS package), it forms a complete stand-alone library for robust 2D mapping.

- http://www.kartorobotics.com/products/
- http://www.ros.org/news/2010/04/karto-mapping-now-open-source-and-on-coderosorg.html

- http://www.dis.uniroma1.it/~grisetti/teaching/lectures-ls-slam-master_2013_14/web/