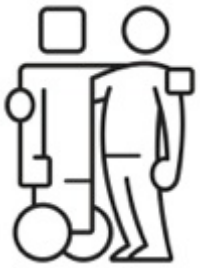
UNIVERSITÉ DE SHERBROOKE



Simultaneous Localization and Mapping (SLAM) with RTAB-Map

Mathieu Labbé

Département de Génie Électrique et Génie Informatique,

IntRoLab, 3IT

CANADA RESEARCH CHAIRS
CHAIRES DE RECHERCHE DU CANADA

Fondation canadienne pour l'innovation

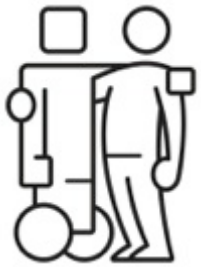
AUTO21

CRSNG
NSERC

Fonds de recherche
sur la nature
et les technologies
Québec

IRSC CIHR

UNIVERSITÉ DE SHERBROOKE



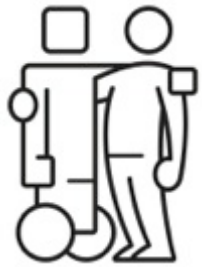
Plan

- Demo

- RTAB-Map
  - Overview
  - Sensors
  - Visual odometry
  - Loop closure detection
  - Graph optimization

- Online long-term mapping
- ROS (rtabmap_ros)
- Conclusion

UNIVERSITÉ DE SHERBROOKE

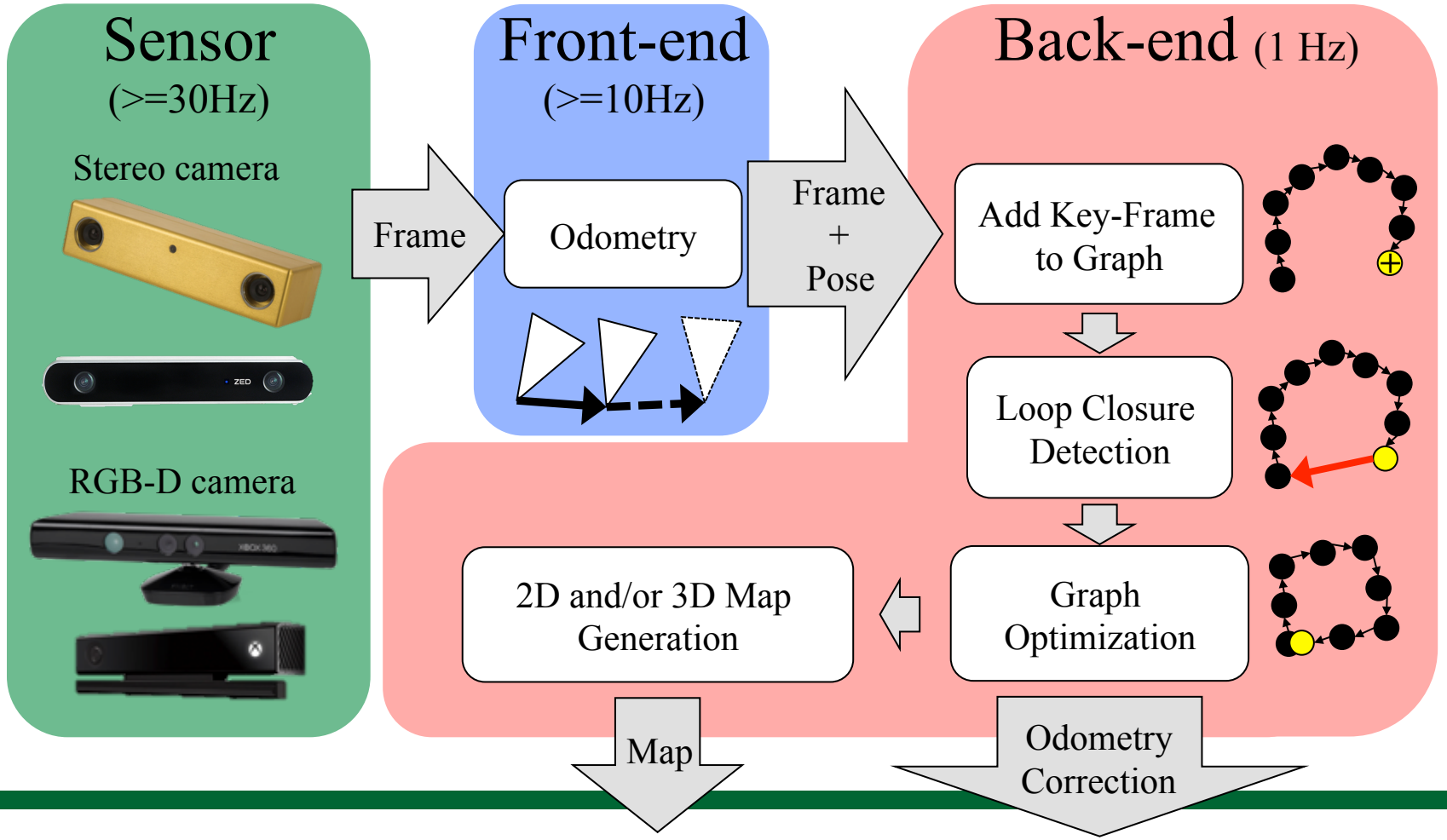


Demo!

https://youtu.be/Bh8WZsU4YC8

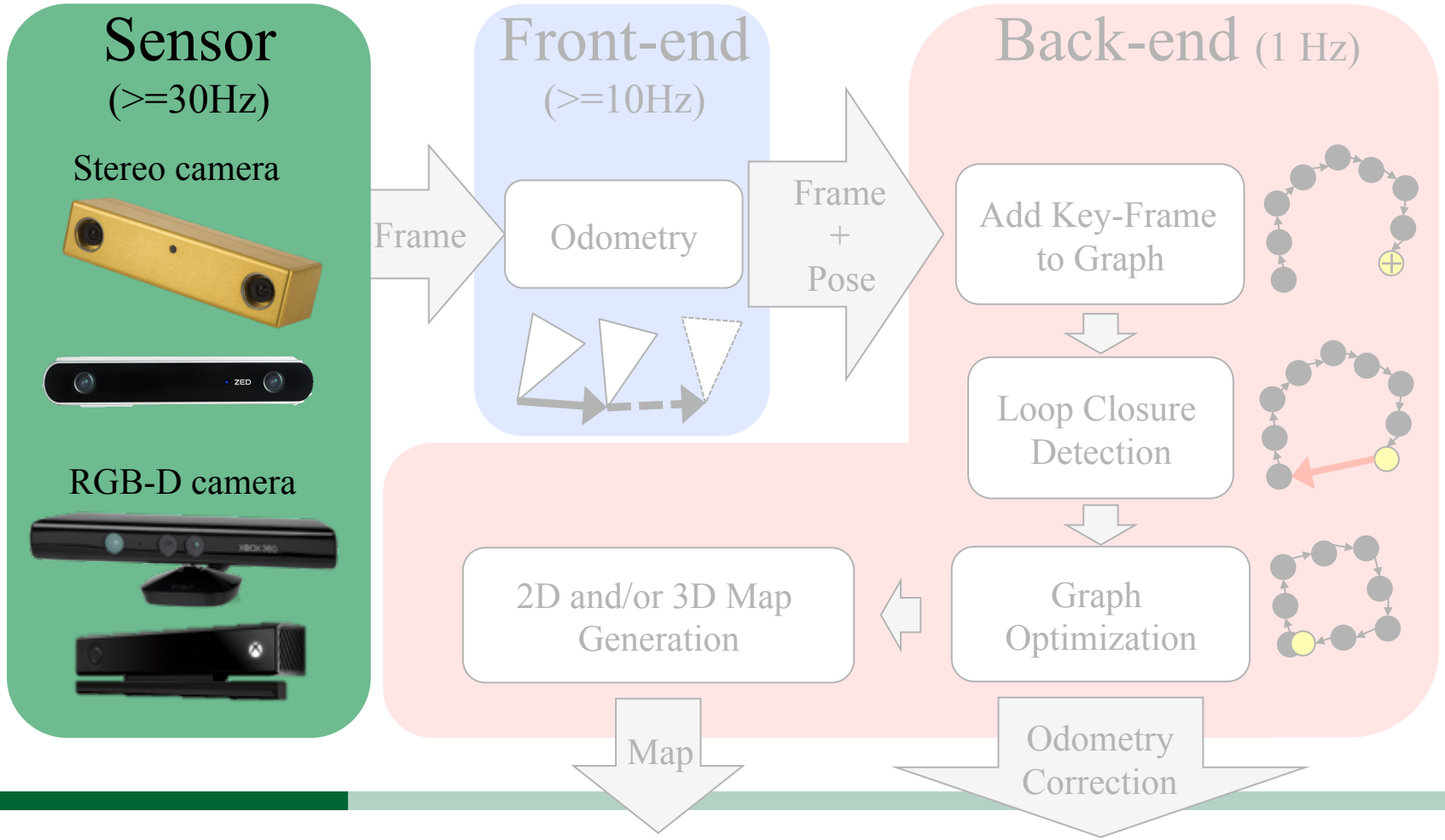
UNIVERSITÉ DE SHERBROOKE

RTAB-Map: Real-Time Appearance-Based Mapping

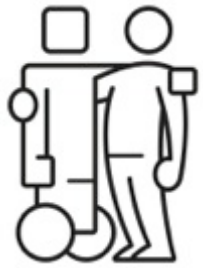


UNIVERSITÉ DE SHERBROOKE

RTAB-Map: Real-Time Appearance-Based Mapping



UNIVERSITÉ DE SHERBROOKE

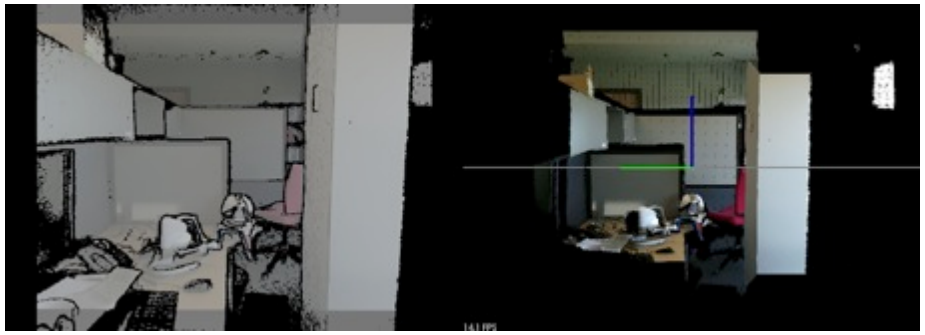


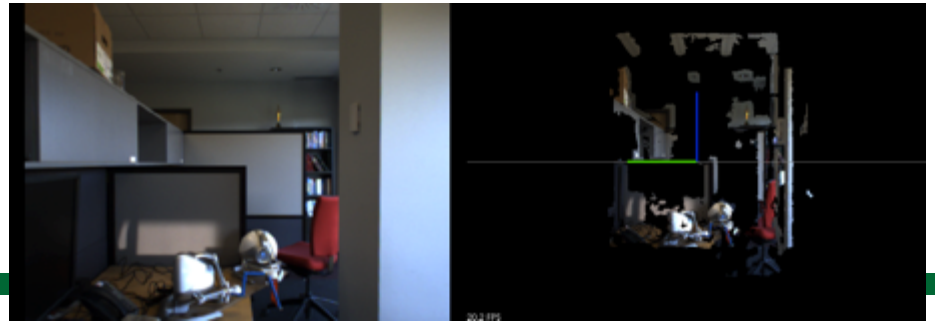
Sensors

- Kinect for Xbox 360
- Xtion PRO LIVE
- USB2
- ~0.4 m to ~3.5 m

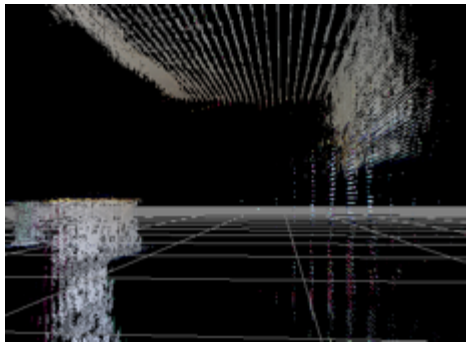
- Kinect for Xbox One
- USB3
- High CPU usage
- ~0.4 m to ~12 m

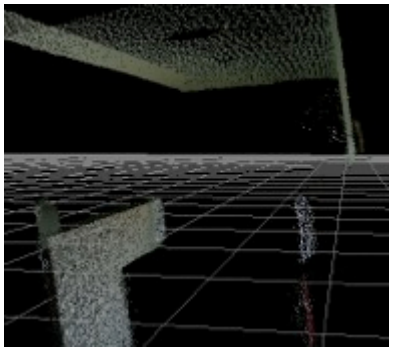
- BumbleBee2
- FireWire
- High price
- ~0.4 m to ~12 m





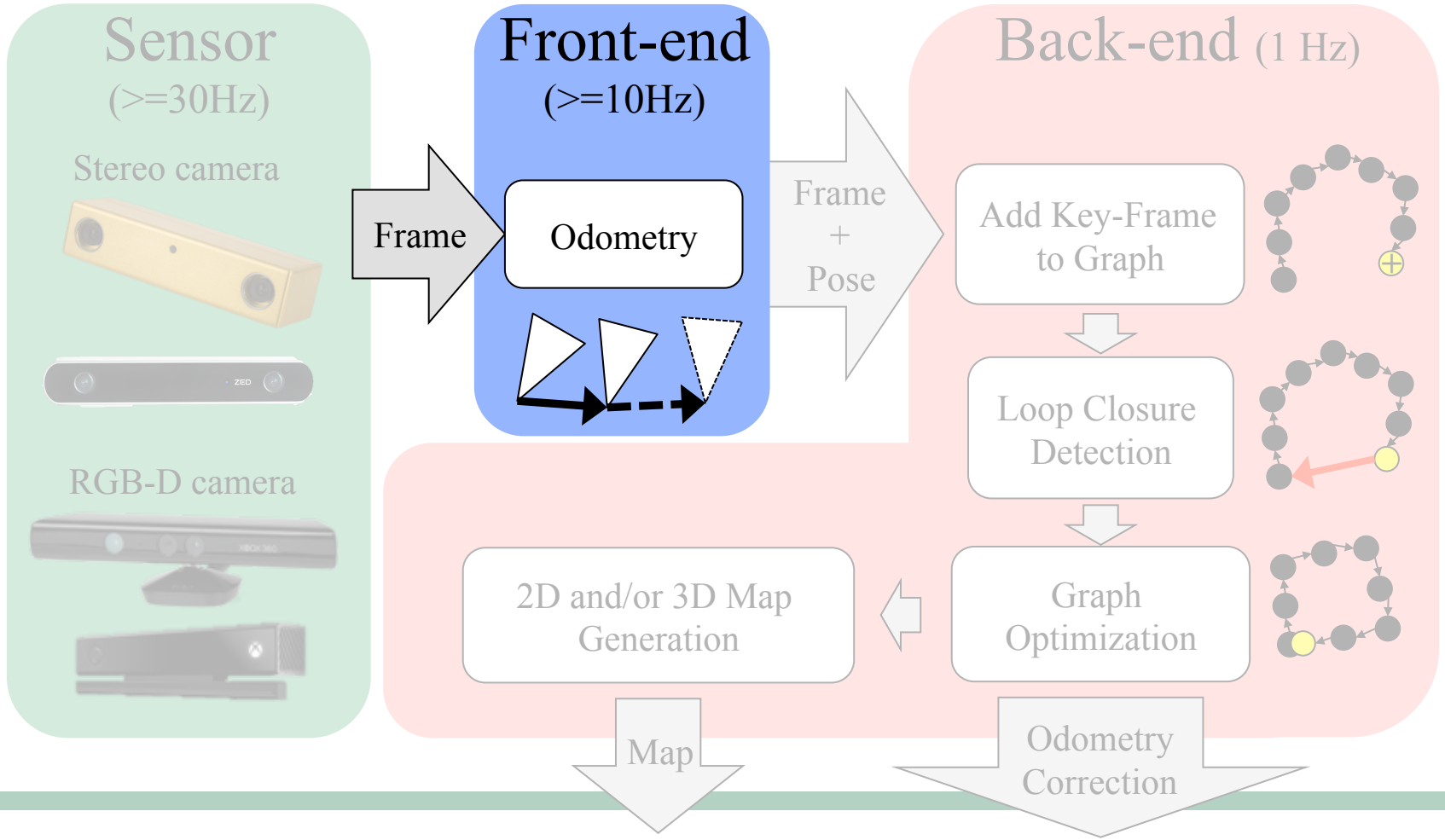
>4 m





UNIVERSITÉ DE SHERBROOKE

RTAB-Map: Real-Time Appearance-Based Mapping



Visual Odometry

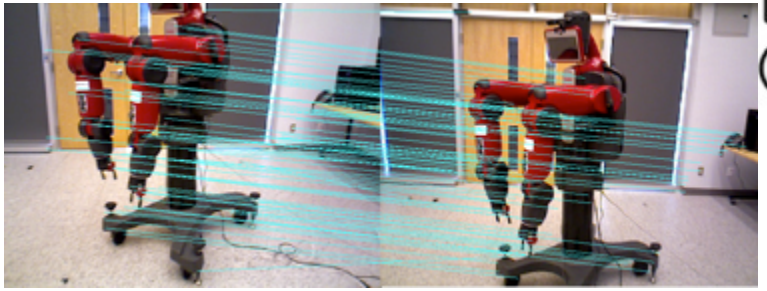
2D Features:

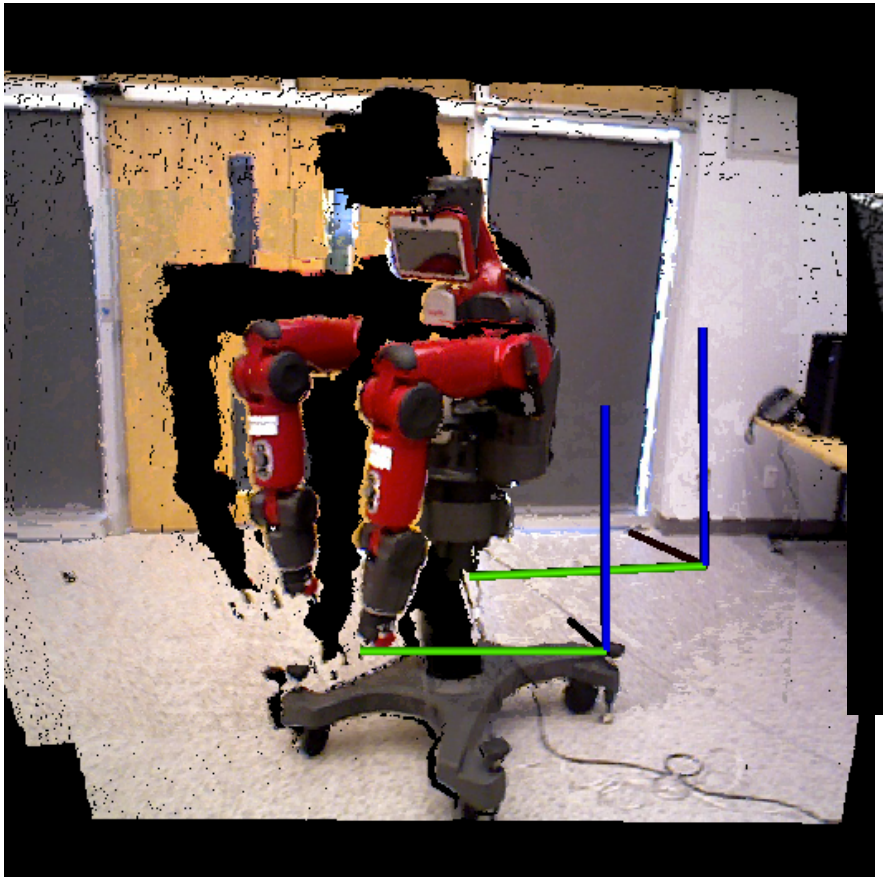
- FAST
- GFTT
- BRISK
- ORB
- BRIEF
- SIFT
- SURF

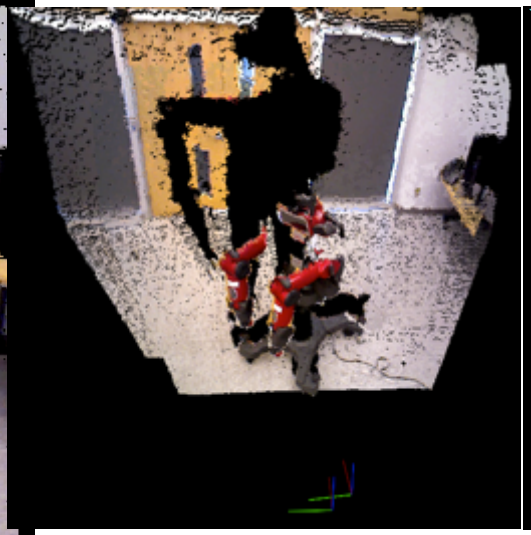
See OpenCV for more…

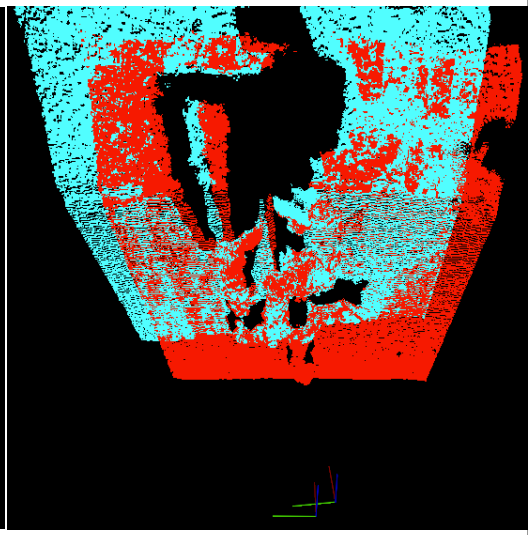
UNIVERSITÉ DE SHERBROOKE

Visual Odometry





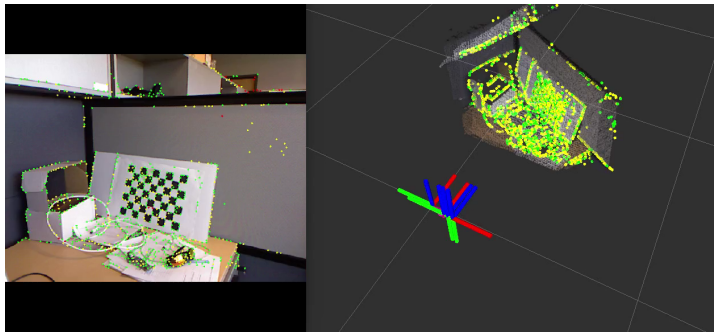




UNIVERSITÉ DE SHERBROOKE

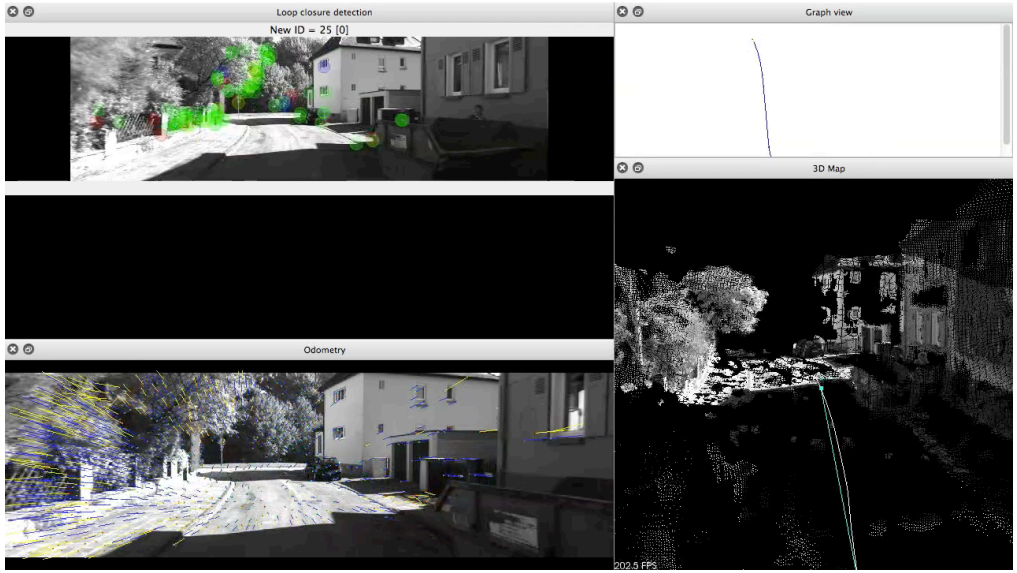
Visual odometry: Correspondences between frames

A-Features matching on a local map of 3D features



https://youtu.be/R9Hu7pUpvfo

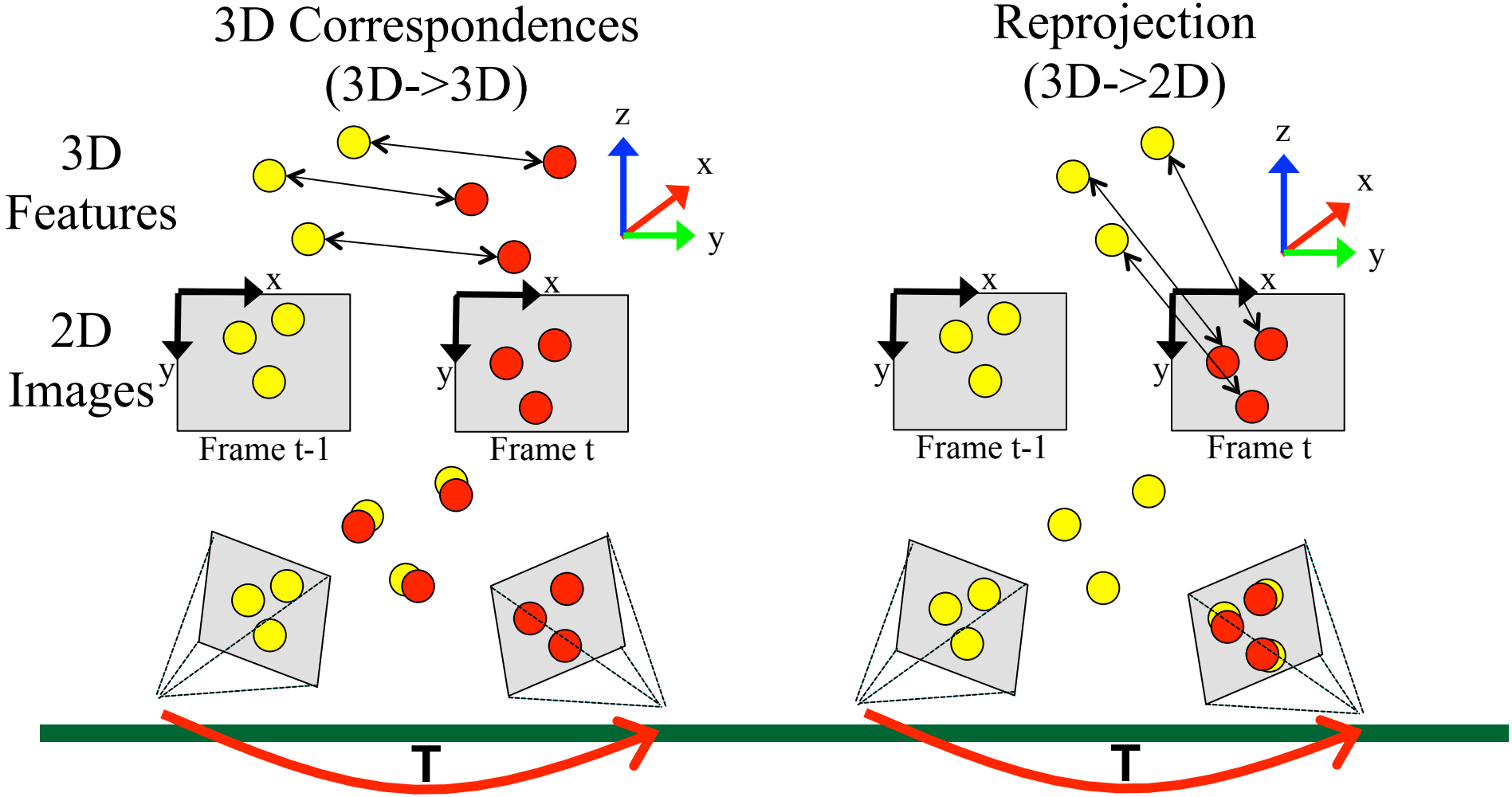
B-Optical flow between consecutive frames



https://www.youtube.com/watch?v=xIGKaE_rZ_Q

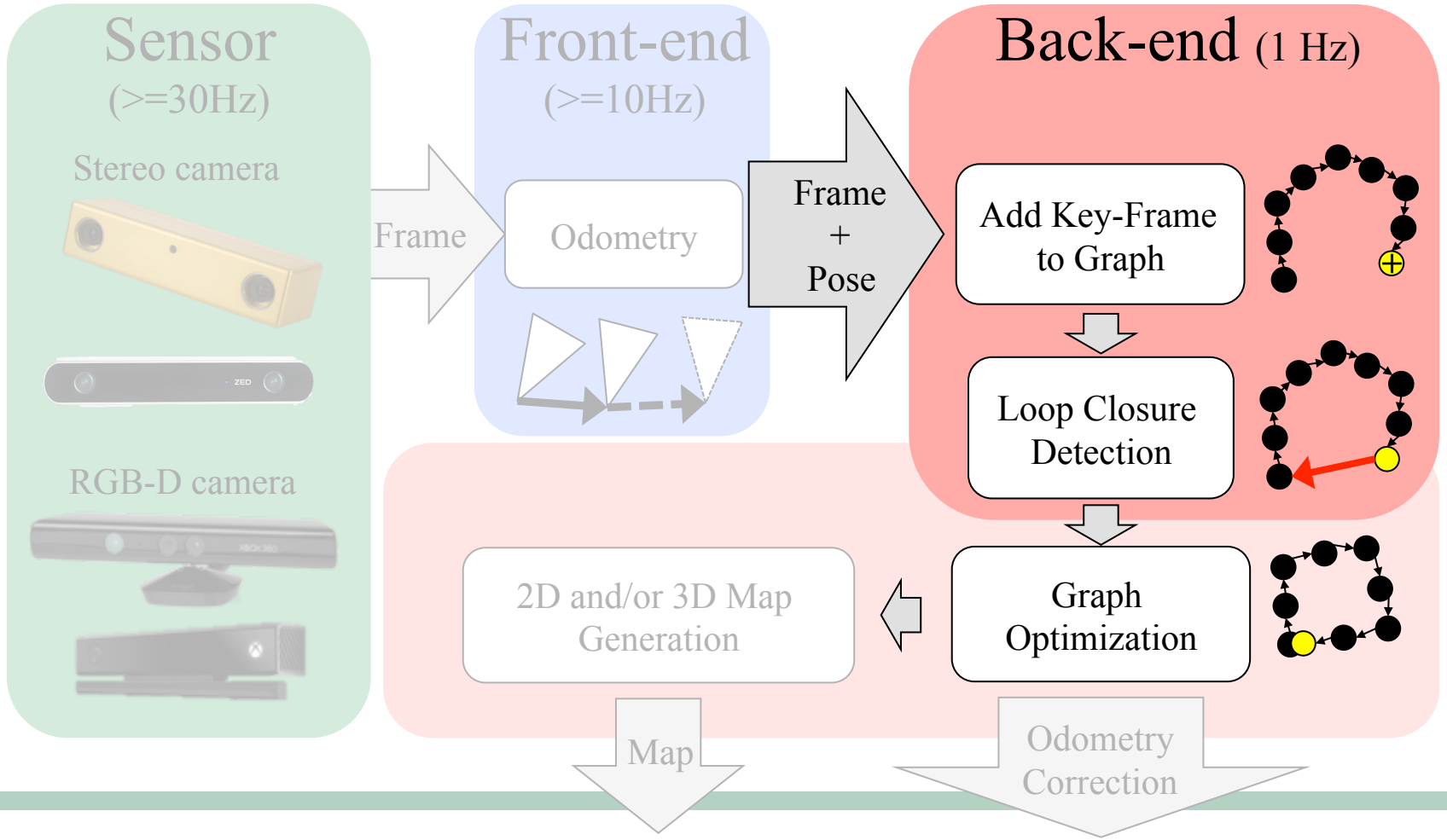
UNIVERSITÉ DE SHERBROOKE

Visual odometry:
Transformation estimation T (x,y,z, roll, pitch,yaw)



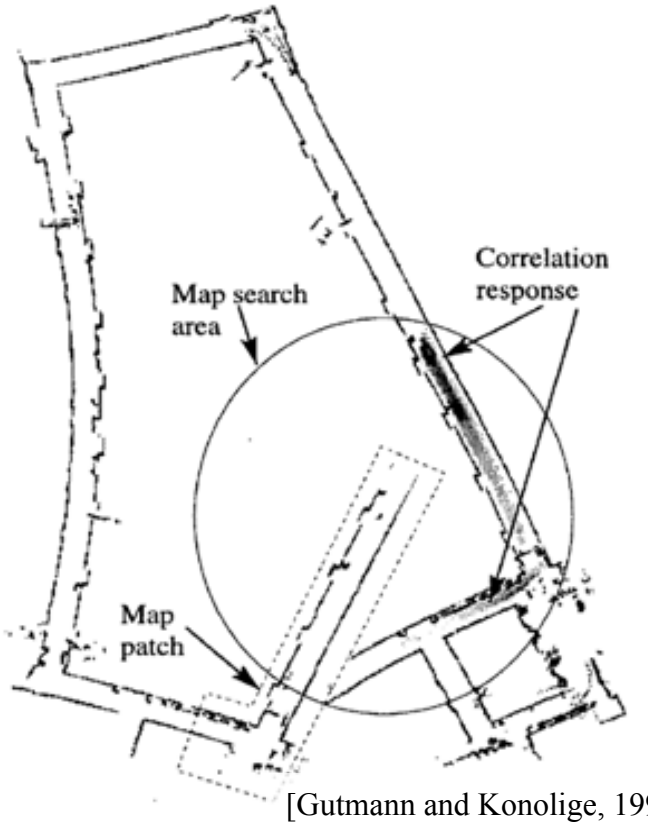
UNIVERSITÉ DE SHERBROOKE

RTAB-Map: Real-Time Appearance-Based Mapping

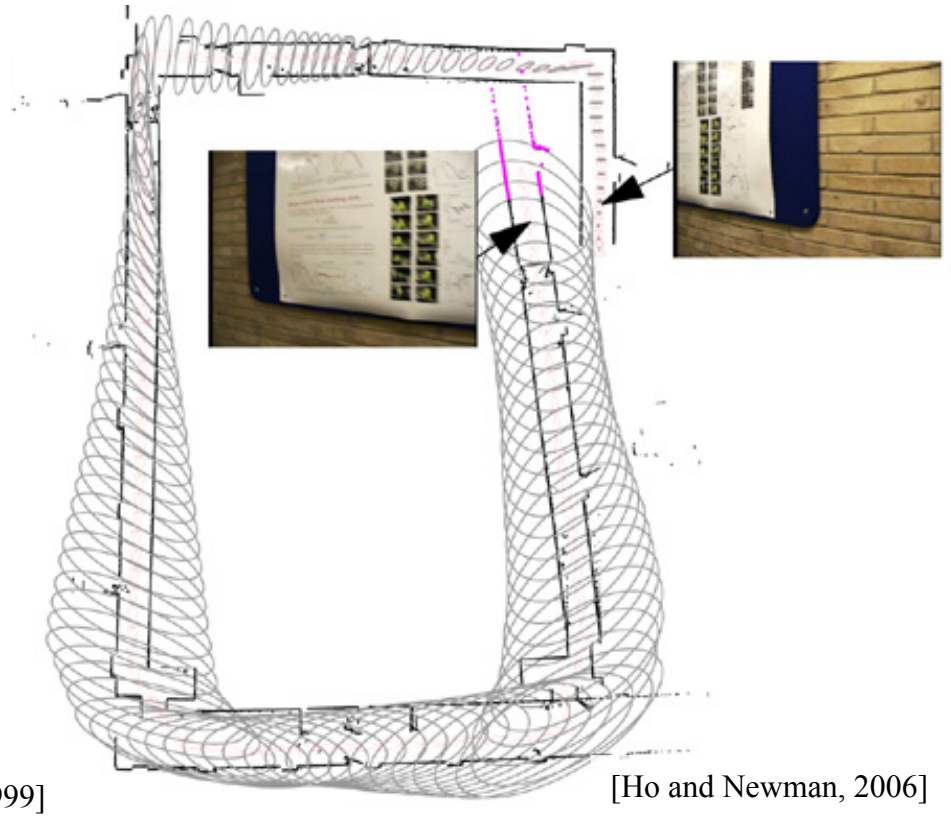


Local loop closure detection

- Dependent on the estimated position (odometry).



[Gutmann and Konolige, 1999]

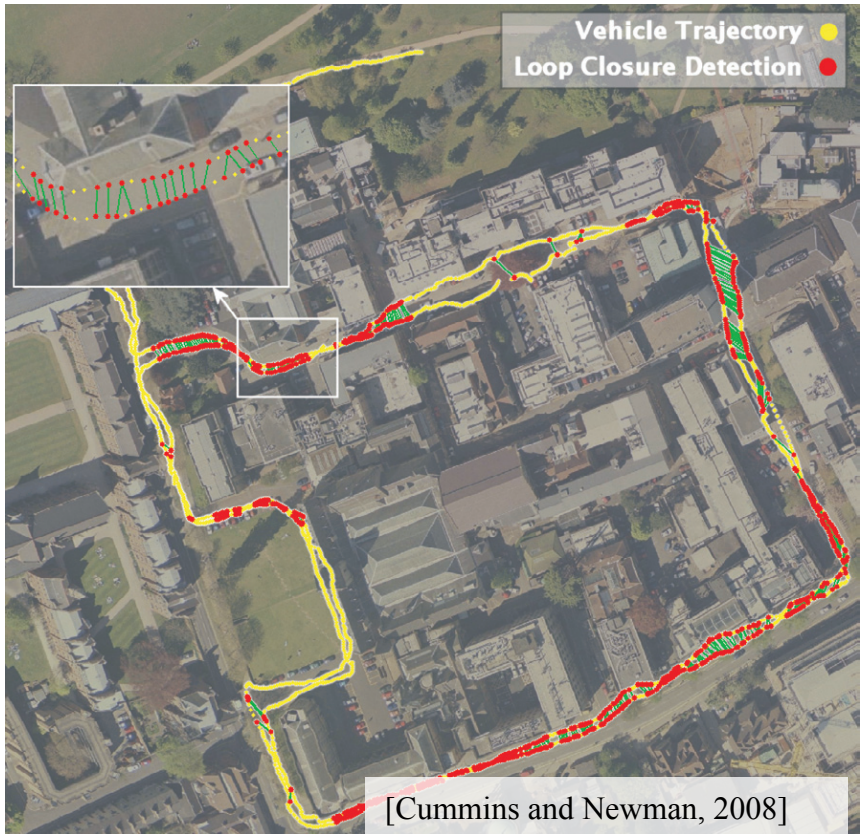


[Ho and Newman, 2006]

UNIVERSITÉ DE SHERBROOKE

Global Loop Closure Detection: Bag-of-words

- Independent of the position estimation (odometry).



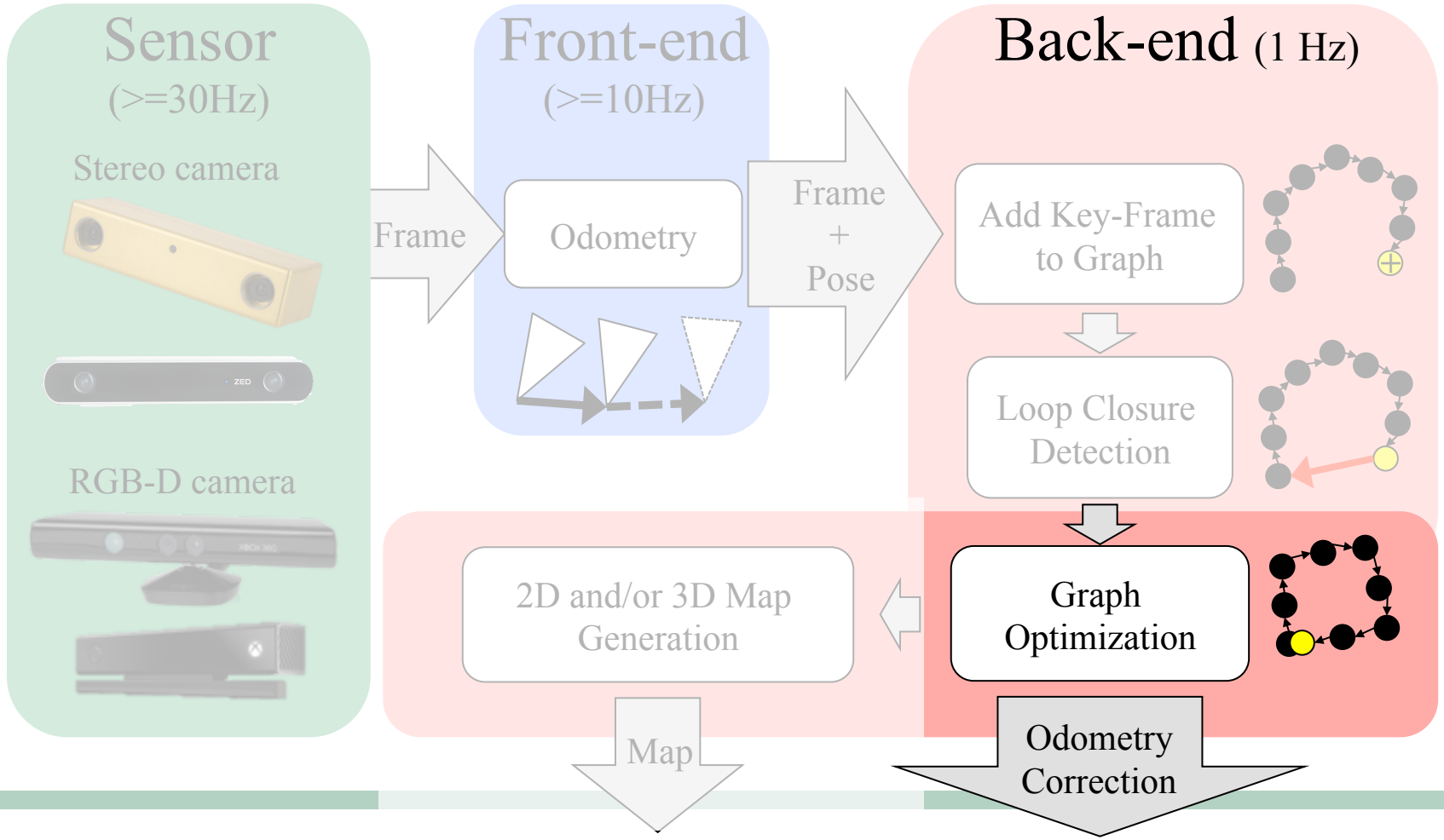
[Cummins and Newman, 2008]

A loop closure…

https://youtu.be/SQiFs1z7qSY

UNIVERSITÉ DE SHERBROOKE

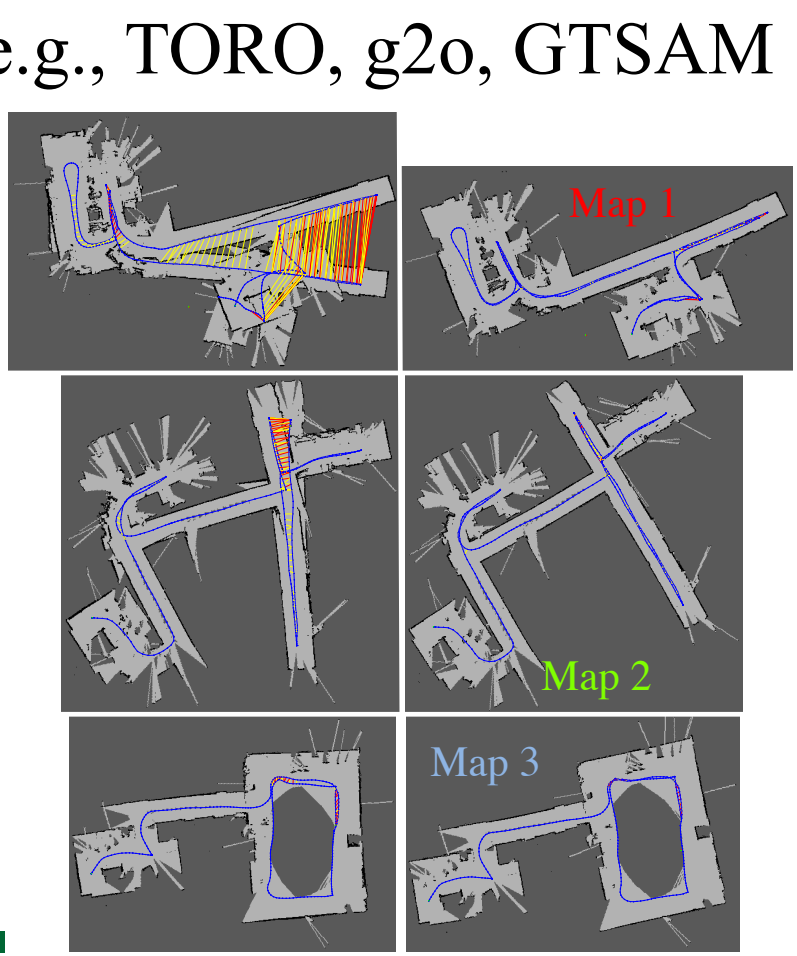
RTAB-Map: Real-Time Appearance-Based Mapping

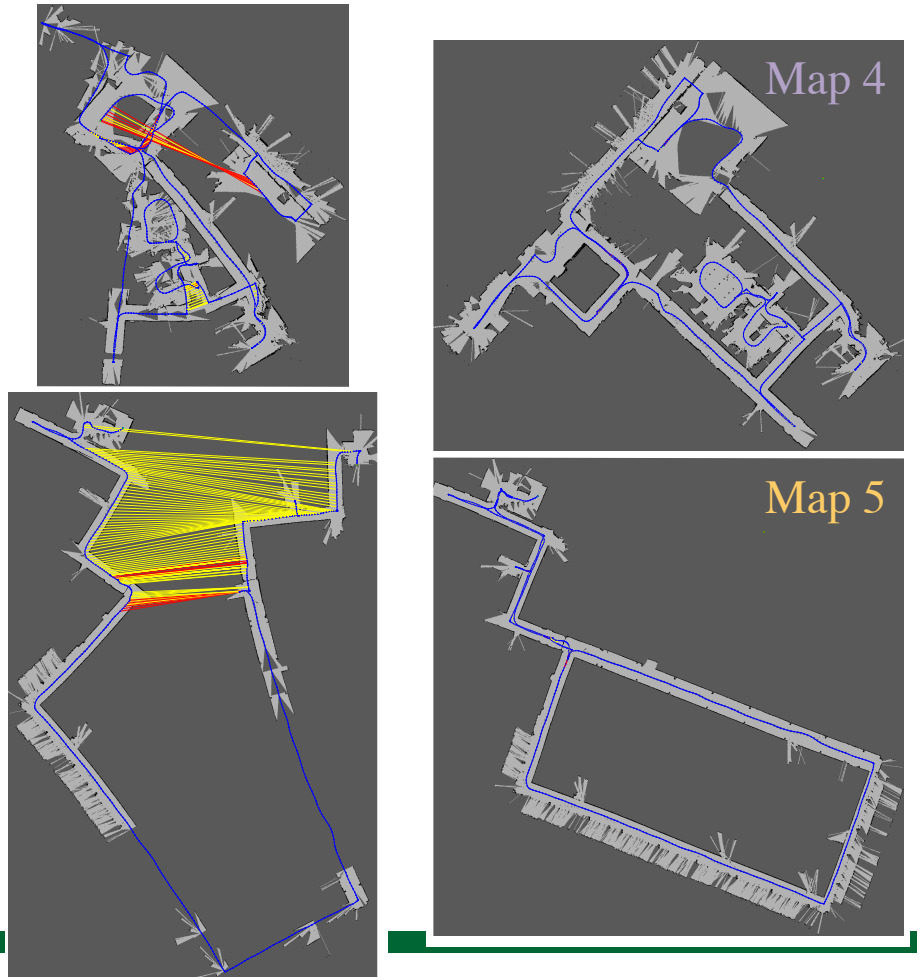


UNIVERSITÉ DE SHERBROOKE

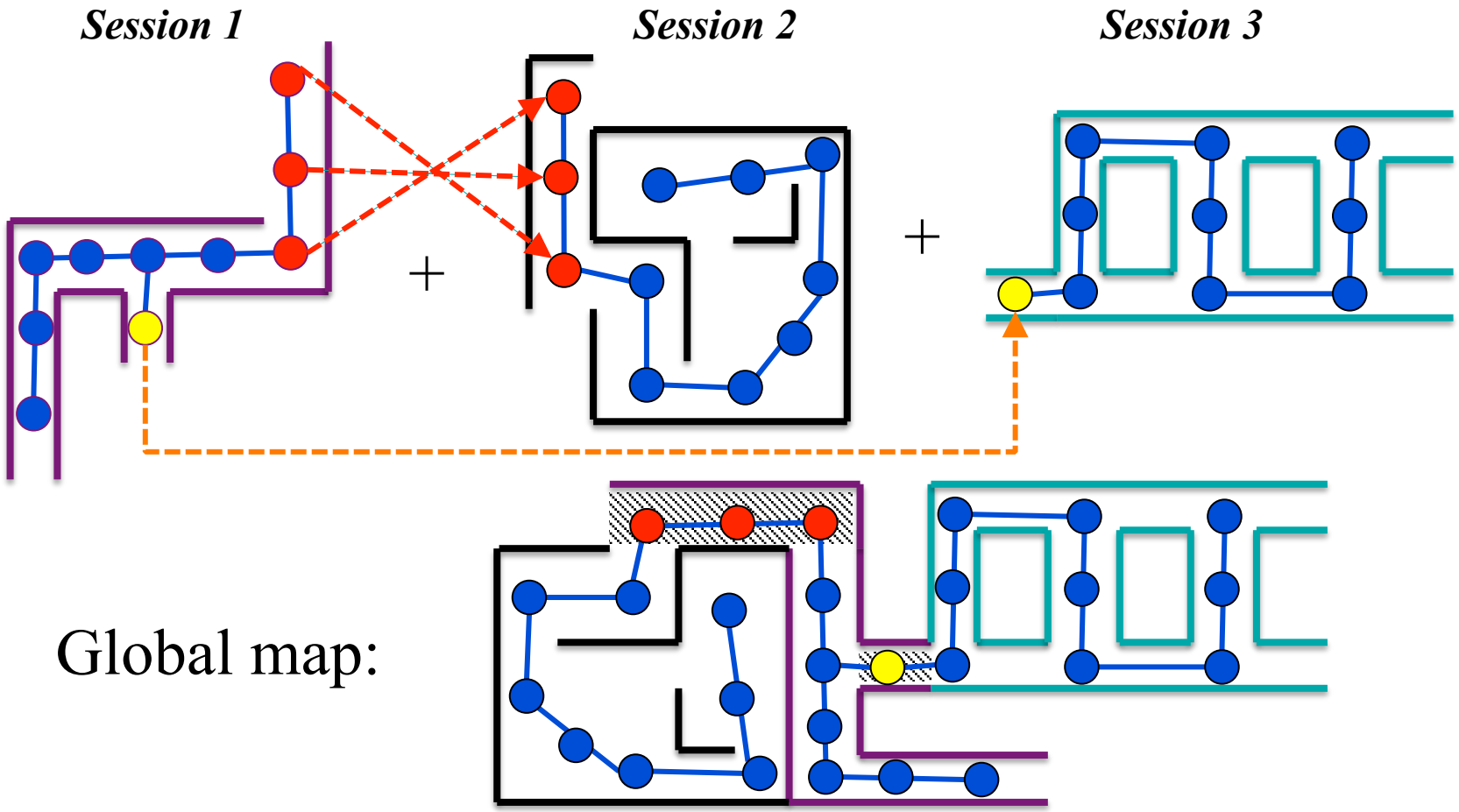
Graph Optimization

e.g., TORO, g2o, GTSAM



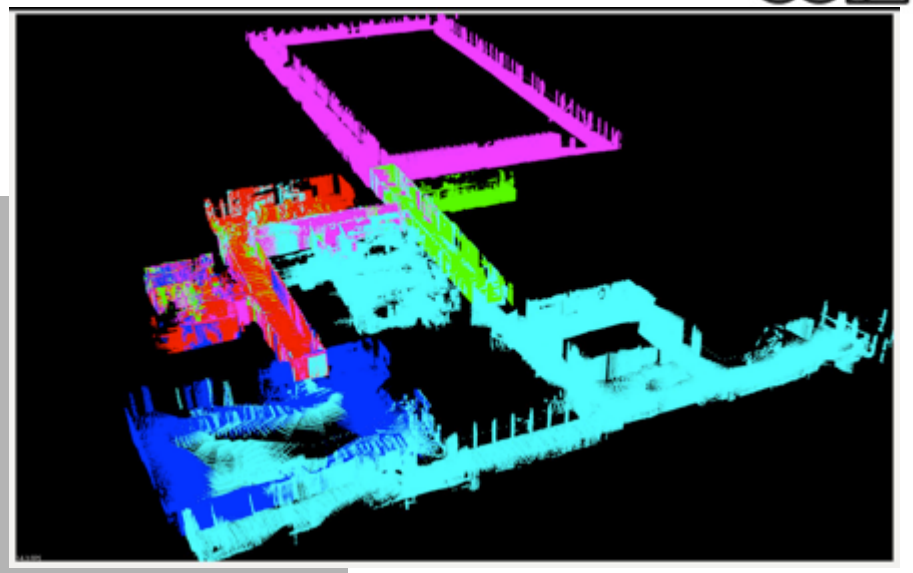


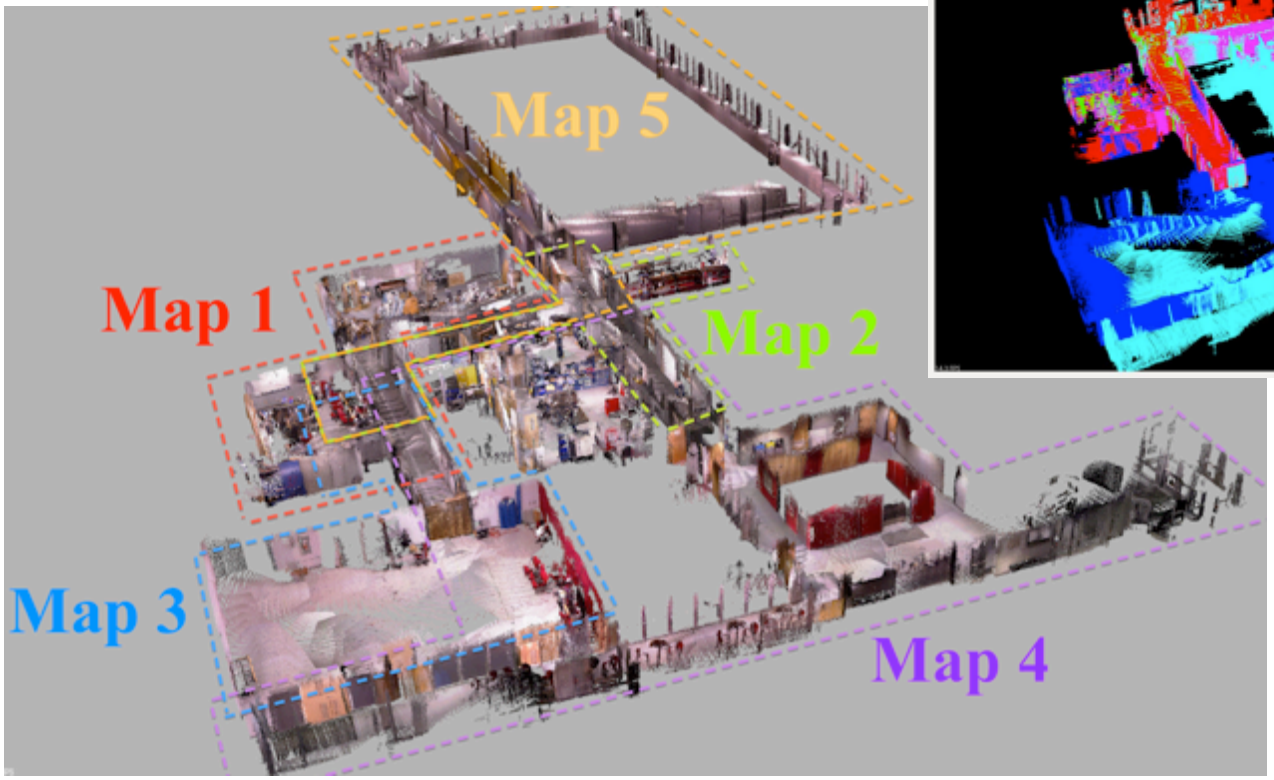
Multi-session



UNIVERSITÉ DE SHERBROOKE

Multi-session

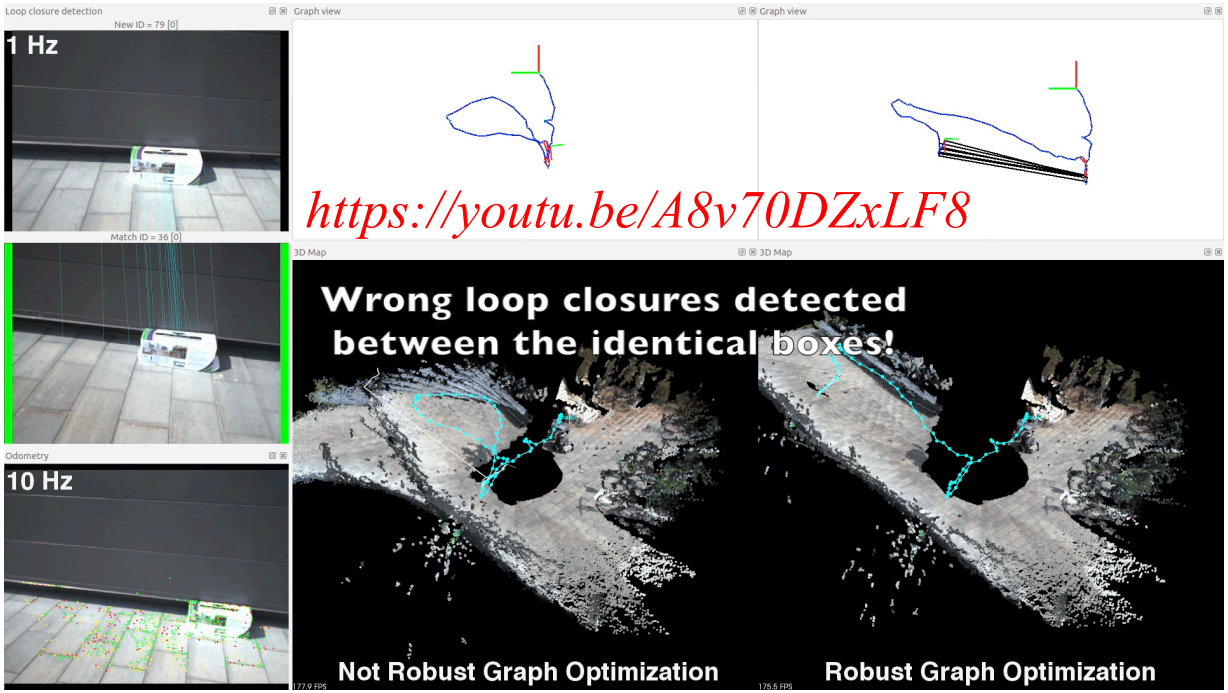




UNIVERSITÉ DE SHERBROOKE

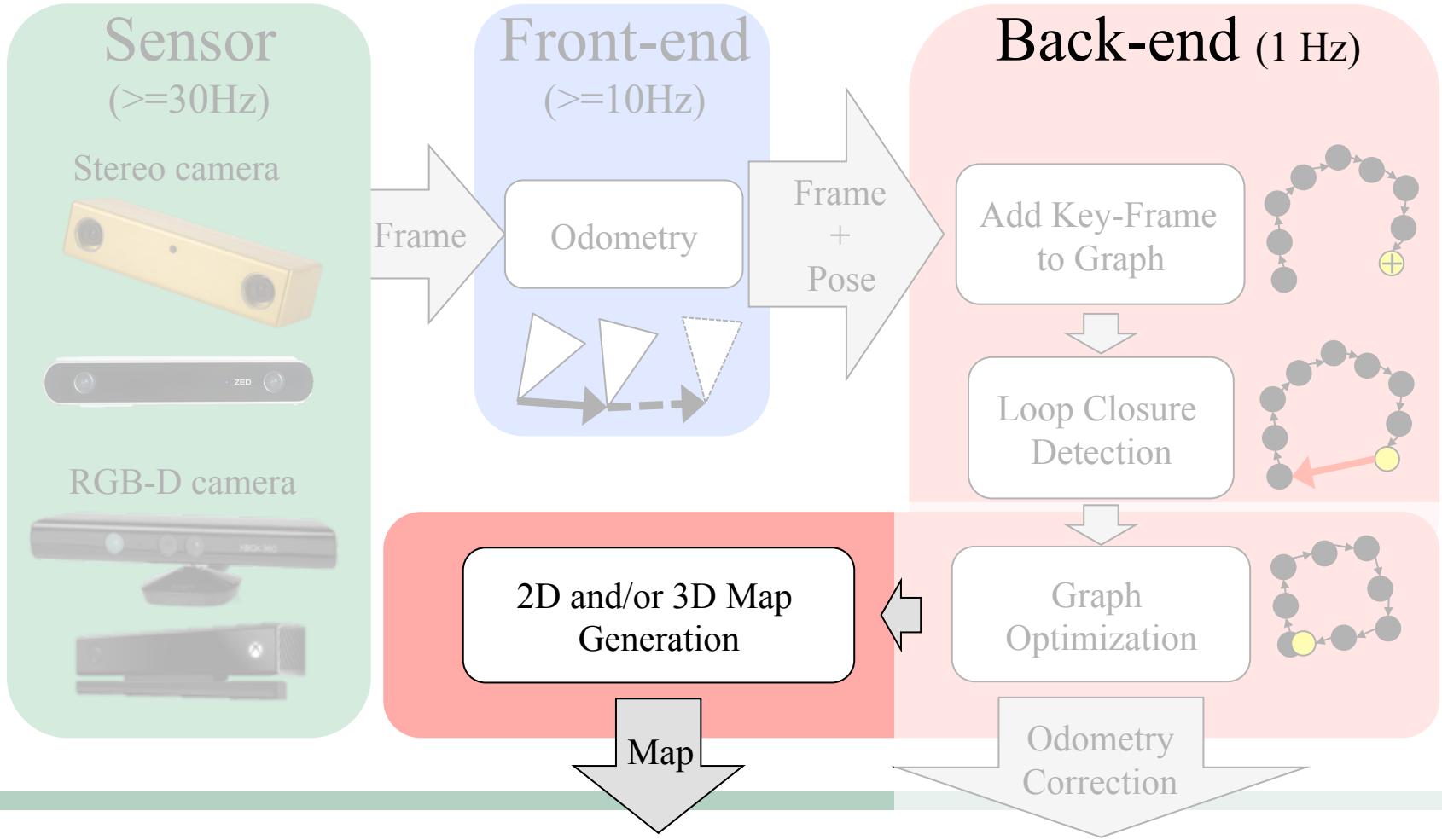
Graph Optimization

Robust optimization with Vertigo



UNIVERSITÉ DE SHERBROOKE

RTAB-Map: Real-Time Appearance-Based Mapping

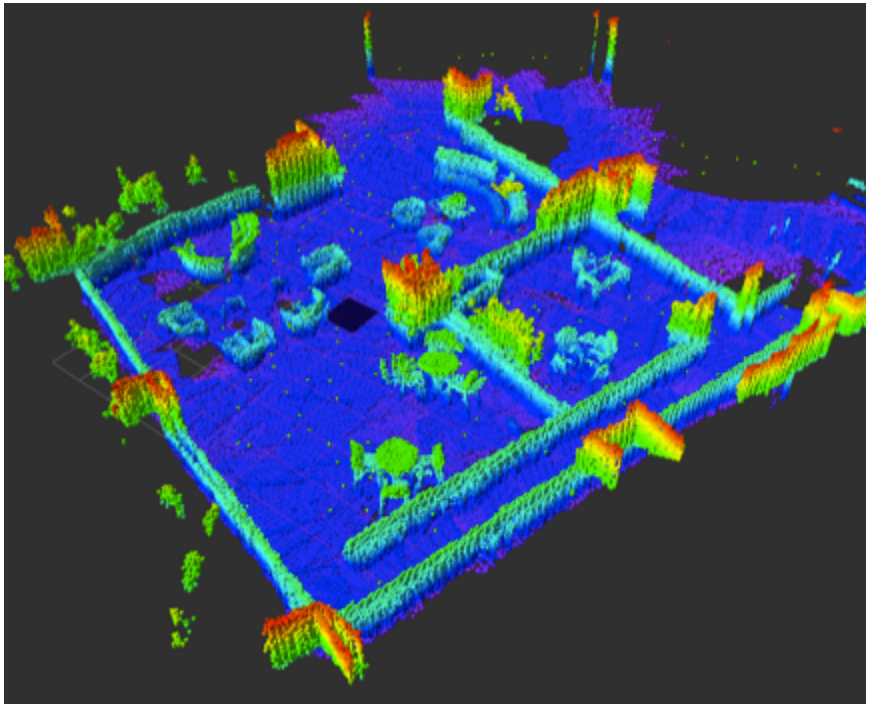


UNIVERSITÉ DE SHERBROOKE

Map Generation

3D (point cloud)

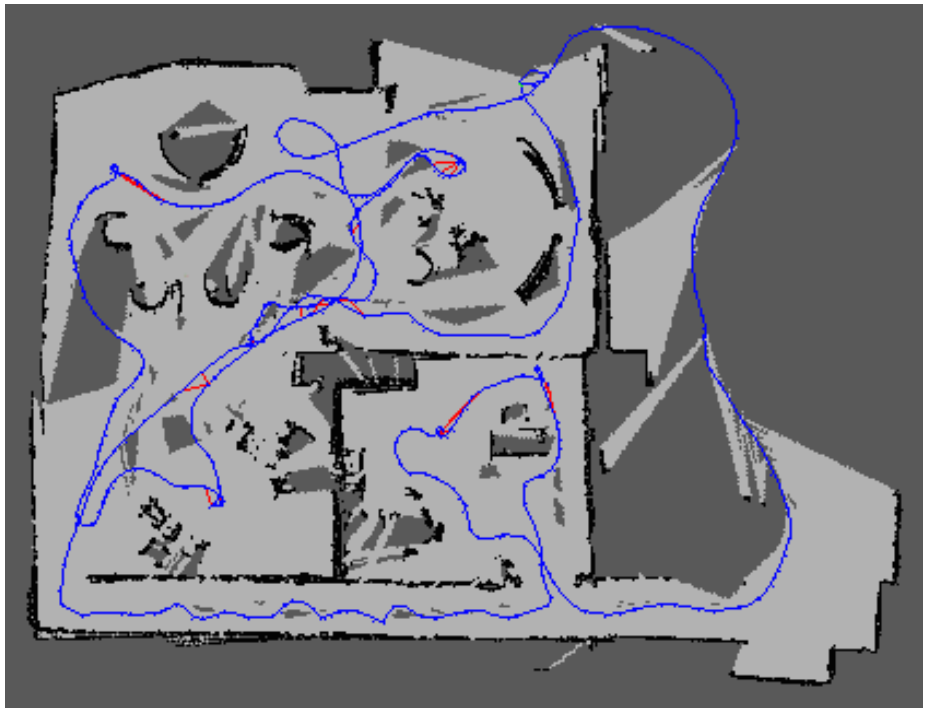
3D (octomap)



Map Generation

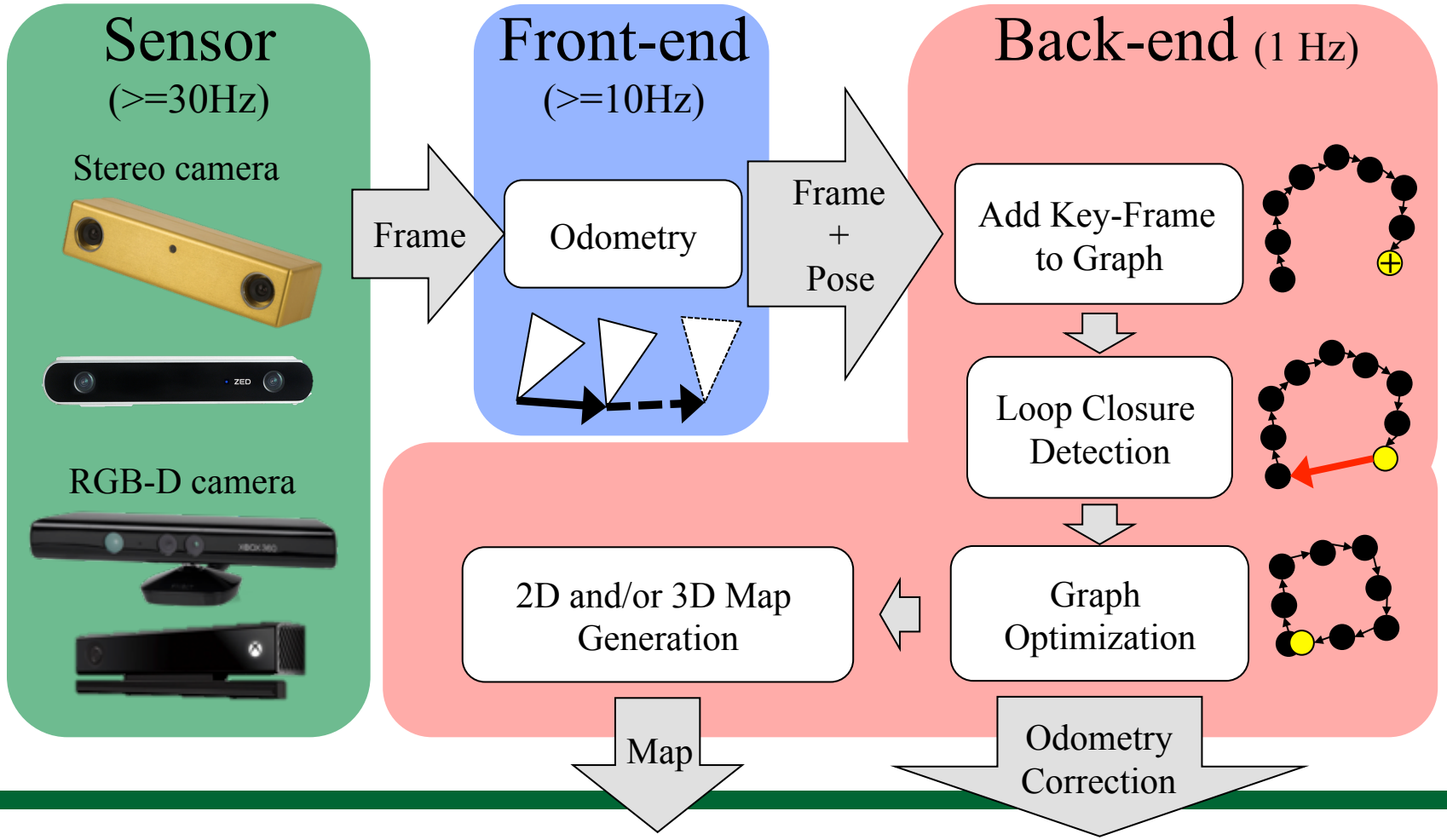
2D (projection)

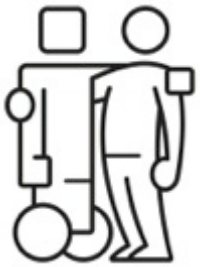
2D (laser scans)



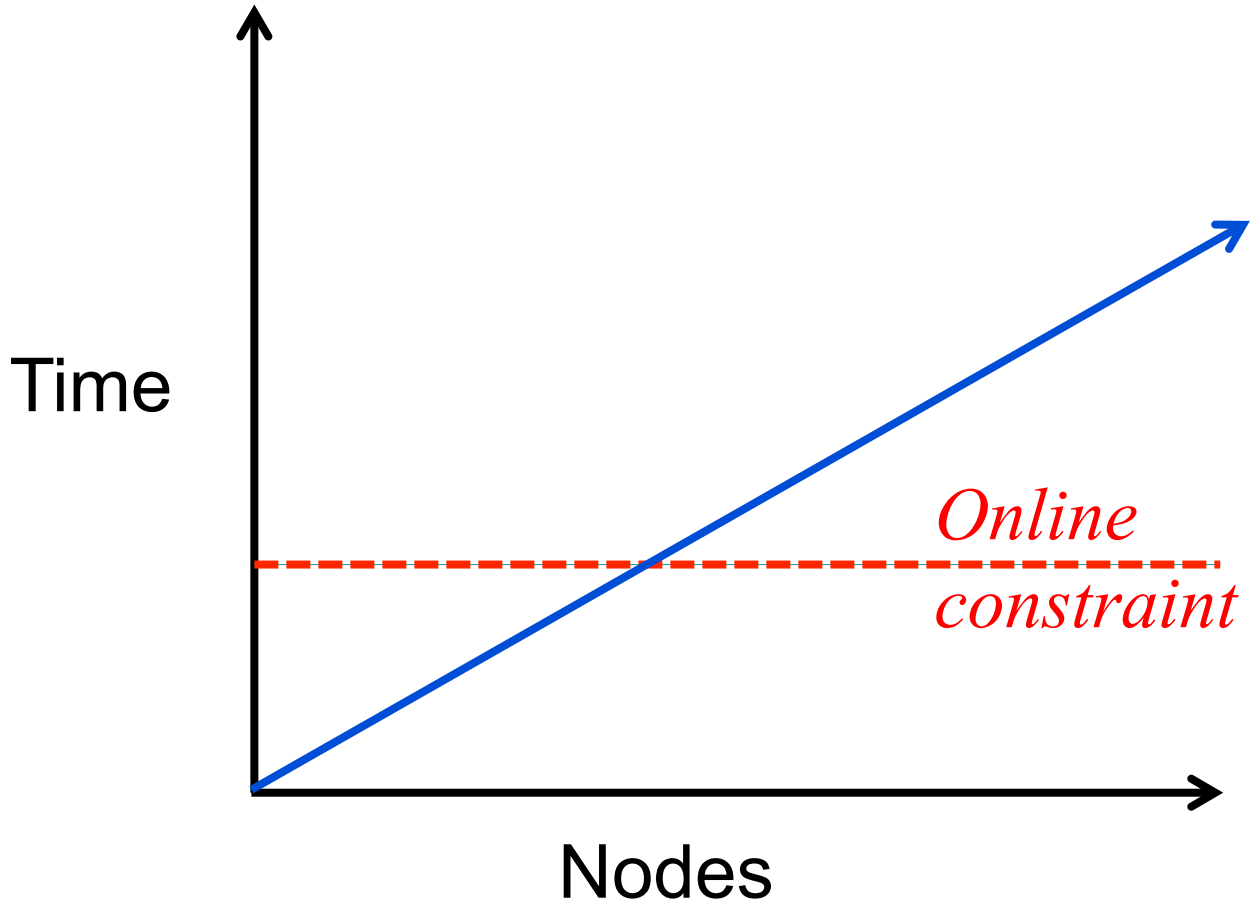
UNIVERSITÉ DE SHERBROOKE

RTAB-Map: Complexity?

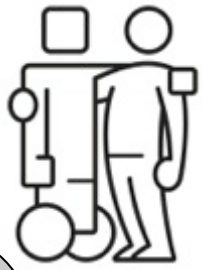




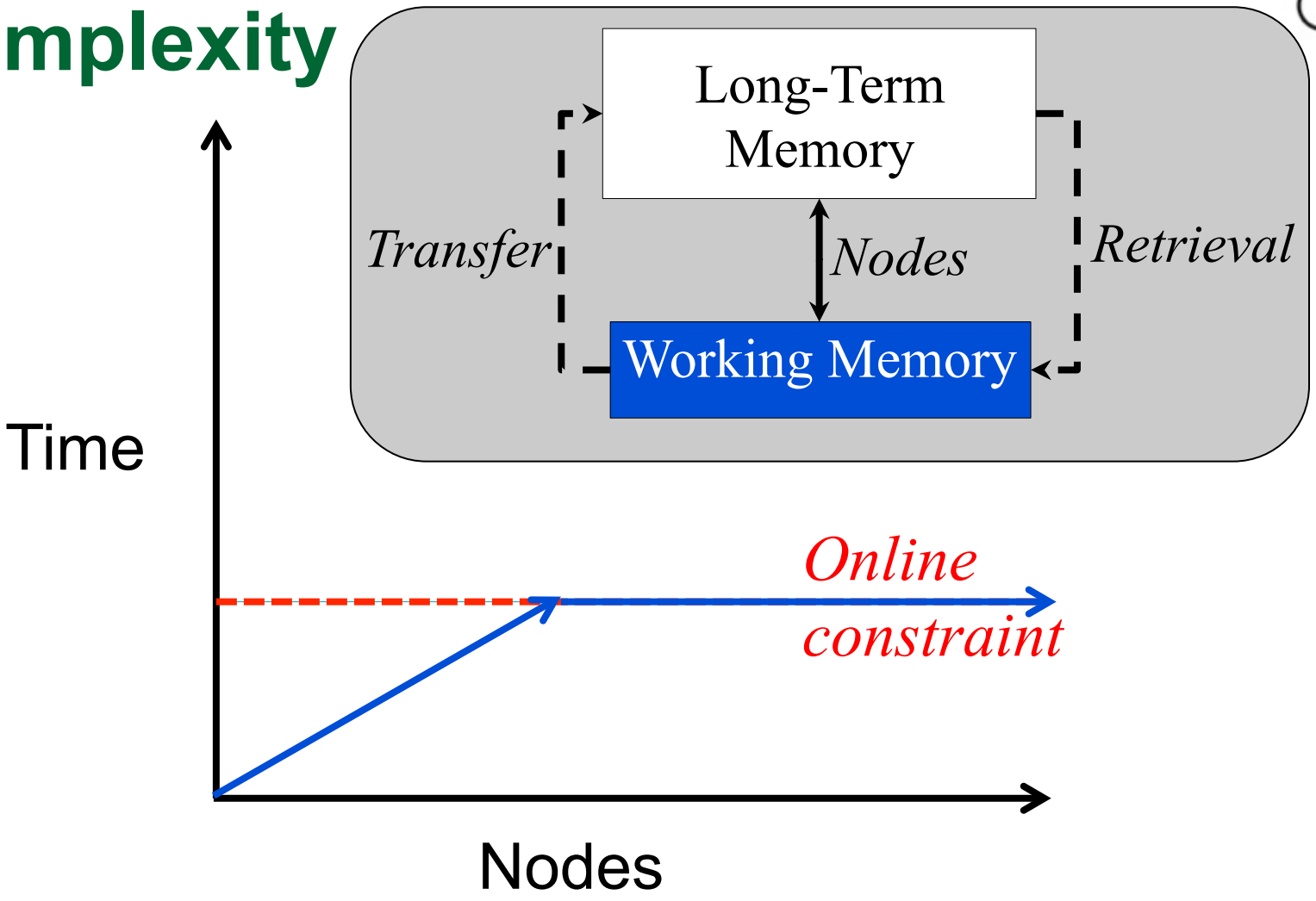
Complexity



Loop closure detection
+
Graph optimization
+
Map generation

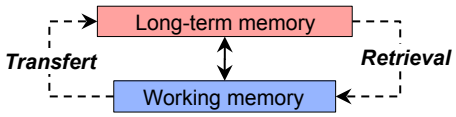


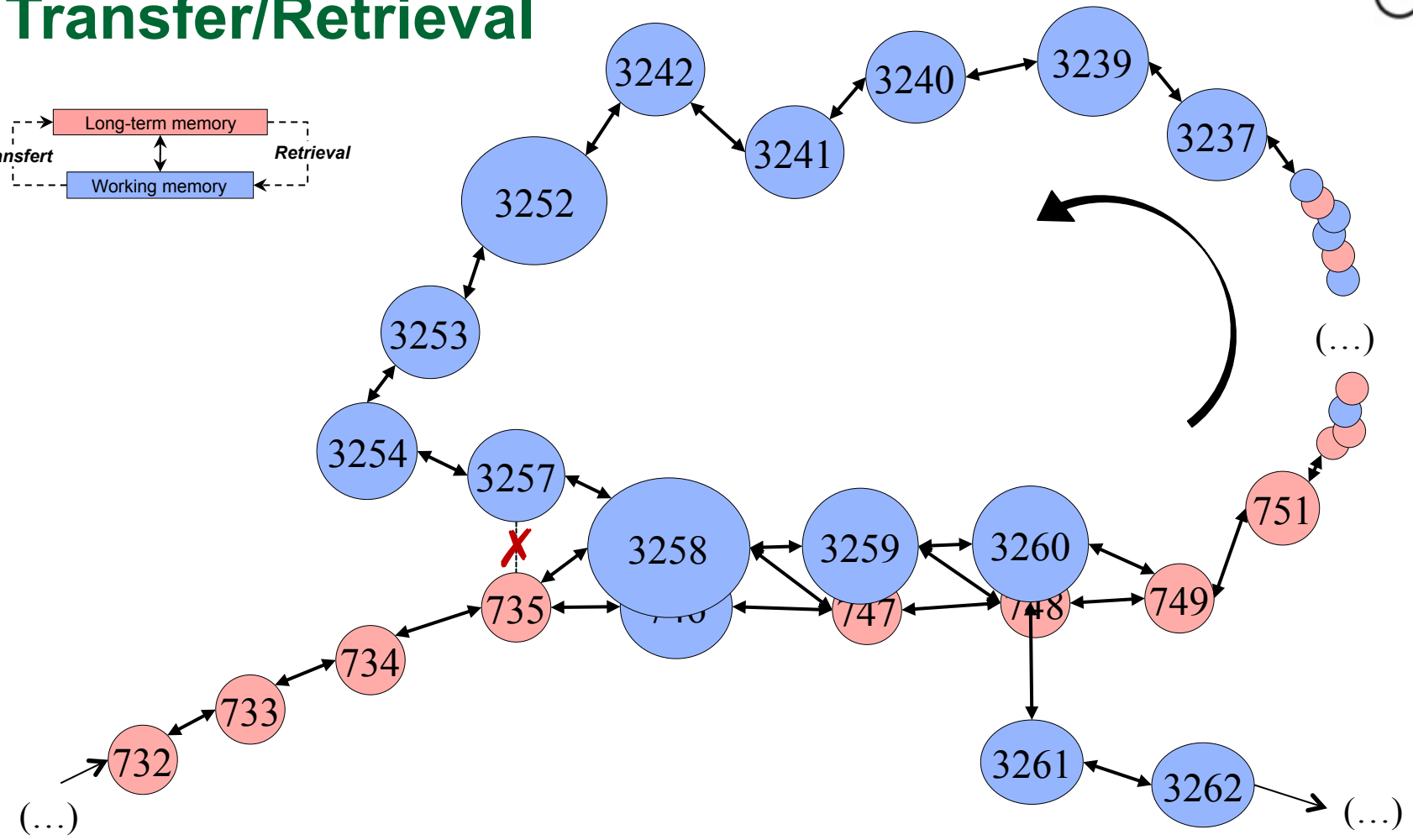
Complexity

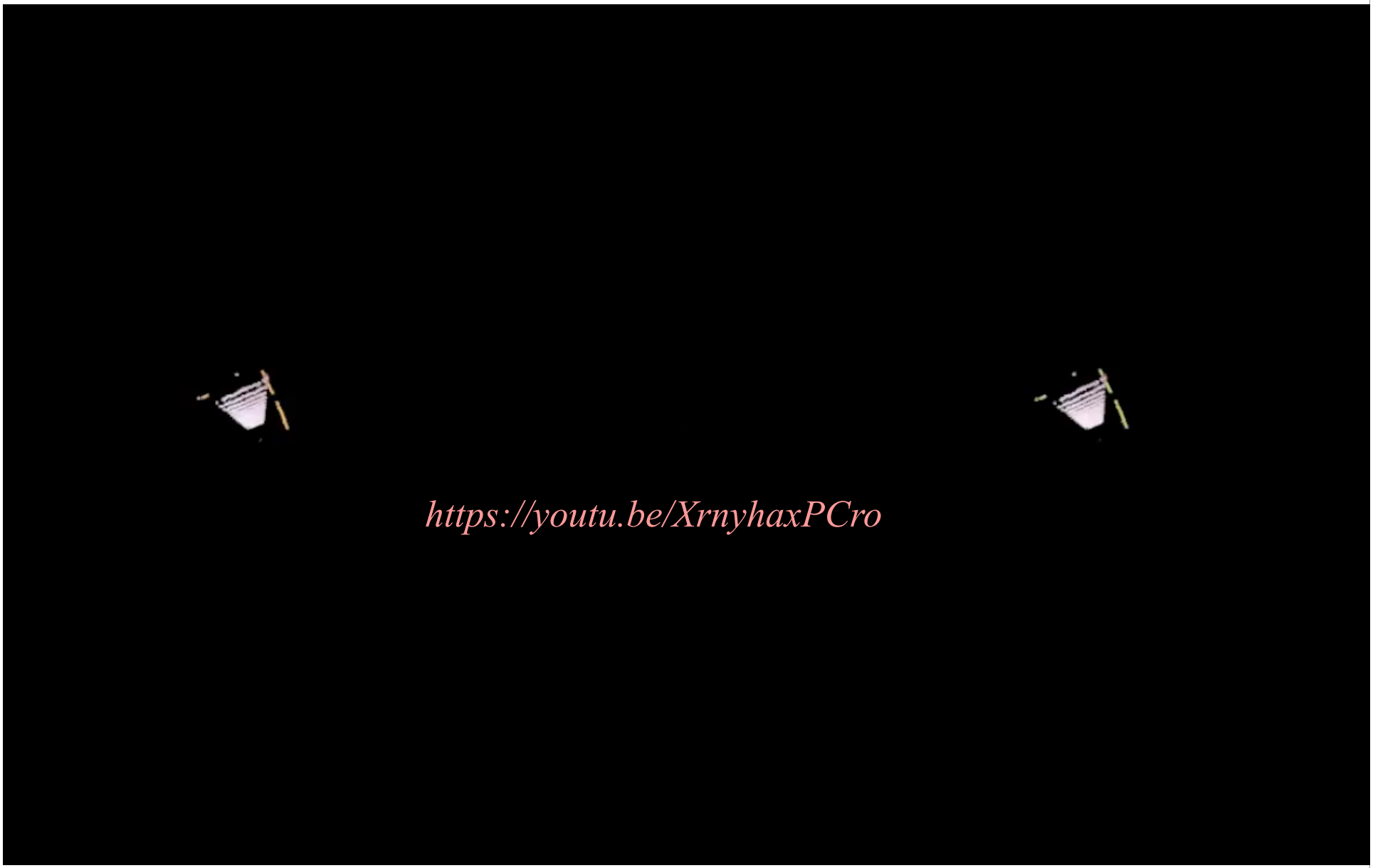

Long-Term Memory
Transfer
Nodes
Retrieval
Working Memory
Time
Online constraint
Nodes

UNIVERSITÉ DE SHERBROOKE

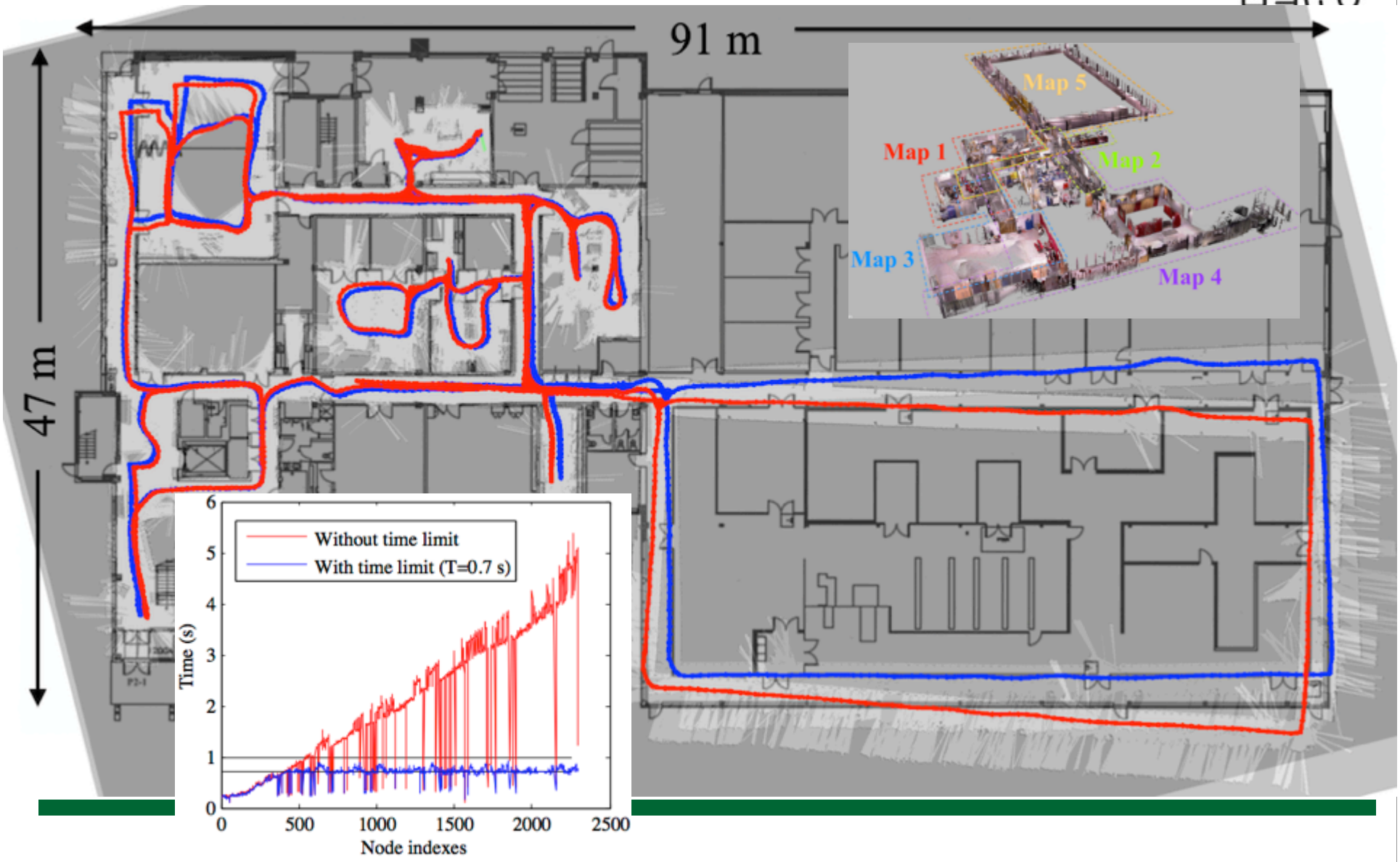
Transfer/Retrieval






https://youtu.be/XrnyhaxPCro

UNIVERSITÉ DE SHERBROOKE

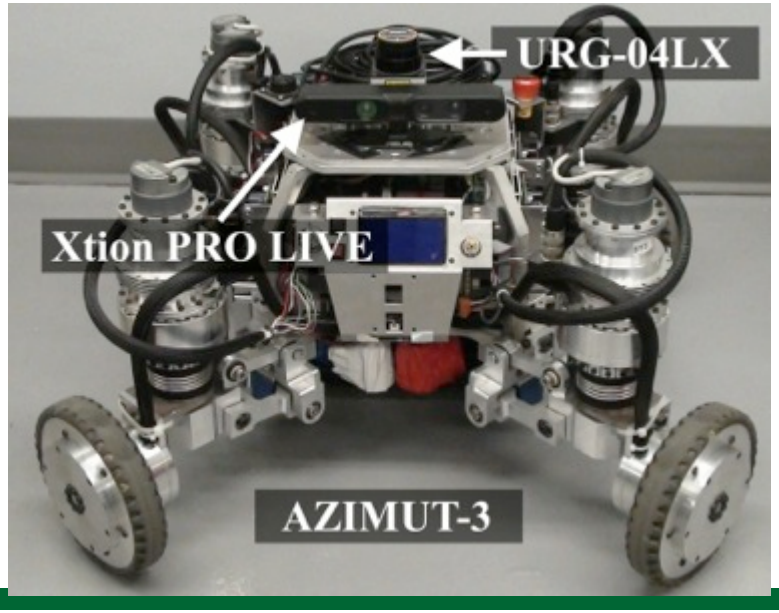


UNIVERSITÉ DE SHERBROOKE

ROS.org: Robot Operating System

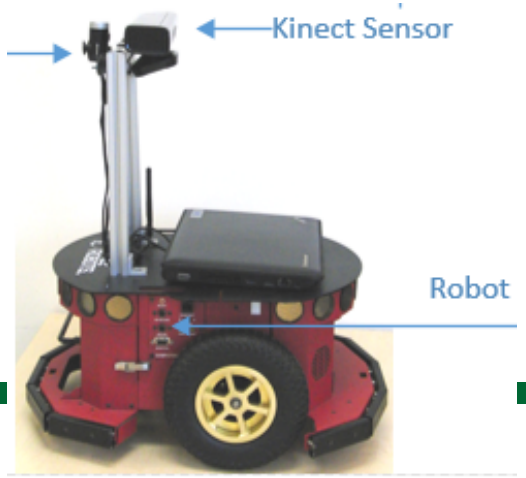
Package: **`rtabmap_ros`**

Wheel odometry + 2D Laser rangefinder + Xtion Live Pro



Stereo-only

Wheel odometry + Kinect

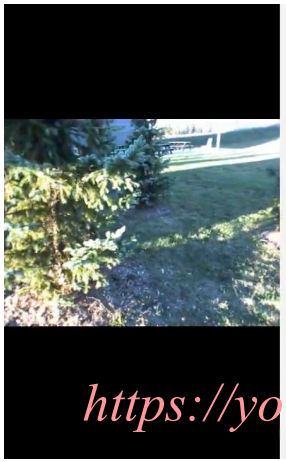


UNIVERSITÉ DE SHERBROOKE

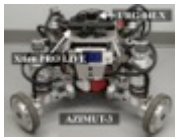
ROS.org: Robot Operating System

Package: `rtabmap_ros`

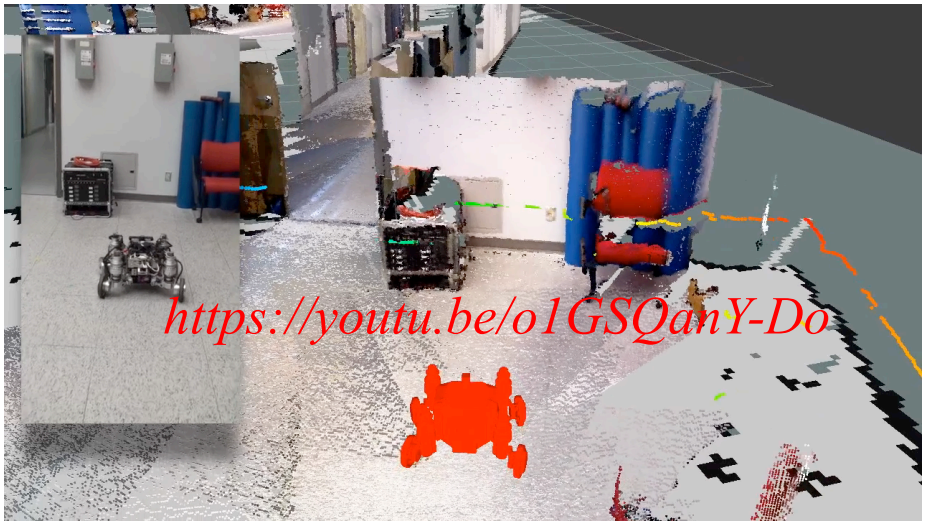
Stereo-only



https://youtu.be/qpTS7kg9J3A



Wheel odometry + 2D Laser rangefinder + Xtion Live Pro



https://youtu.be/o1GSQanY-Do

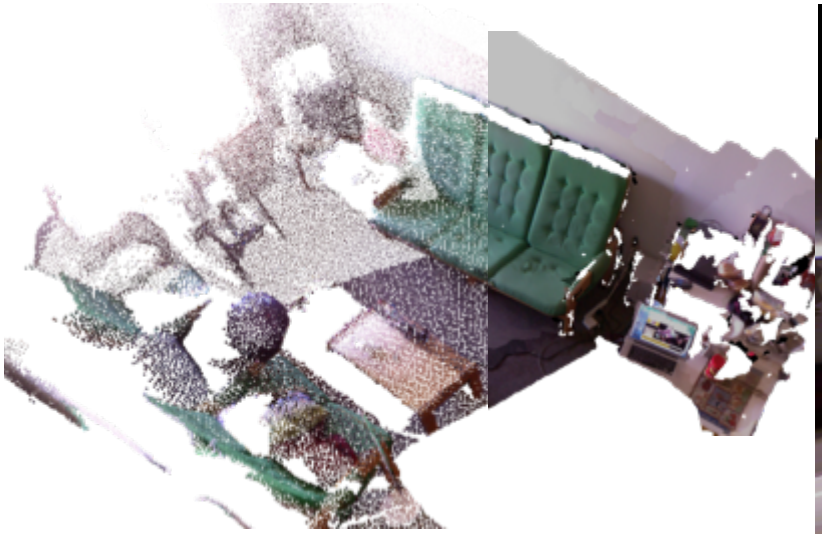
Wheel odometry + Kinect

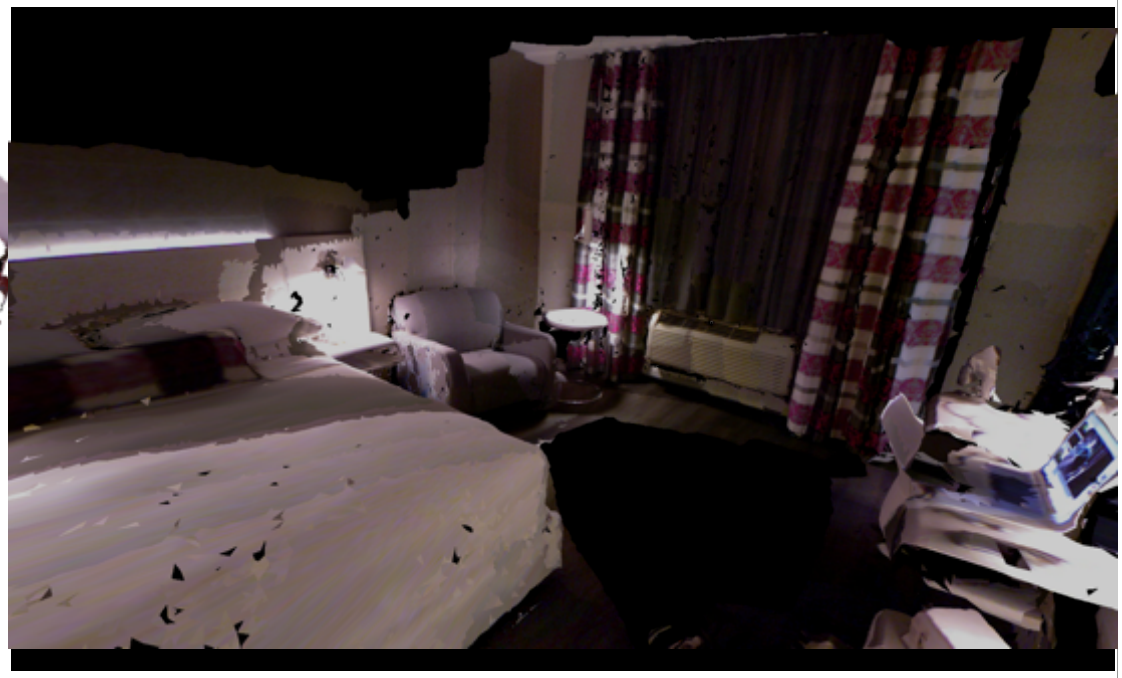
https://youtu.be/_qiLAWp7AqQ

UNIVERSITÉ DE SHERBROOKE

Other stuff…

- Export *.PLY *.OBJ / Refine links with ICP / High resolution point cloud / Meshing / Texturing
- Downloads / tutorials / videos: Google **« rtabmap »**





Questions?