Sensor Alignment Towards an Omni-Directional Measurement using an Intelligent Vehicle

Huijing Zhao  L. Xiong  Z. Jiao  C. Jinshi  H. Zha
Key Lab of Machine Perception (MOE), Peking Univ.

R. Shibsaki
Center for Spatial Information Science, Univ. of Tokyo
Our Goal

We focus on the sensing technologies of intelligent vehicle.

We want to develop an intelligent vehicle of Omni-directional eyes looking at the environment of both static and dynamic objects.

We want to detect the moving objects in the surroundings, and track their states, such as speed, direction, and size, so that dangerous situations can be predicted.

We want to generate a 3D copy of the dynamic urban scenery that contains both stationary objects, e.g. buildings, trees, road etc., and mobile objects, e.g. people, bicycles and cars.
Key Issues

- Sensor Alignment
- Localization
- 3D Mapping
- Mobile objects’ detection, tracking and classification
Framework

Positioning sensors

GPS, IMU

SLAM with MODT

Vehicle Pose, 2D Map (static), 2D Mobile Object

Environmental sensors

Laser Scanners, Cameras

Environmental Perception

3D Map (Static & Mobile)
Processor 1
Sensor Data Logger

GPS/IMU
L1
...
L5

Processor 2
SLAM with MODT

GPS/IMU
L1

Processor 3
3D Mapping

Vehicle Pose

Processor 4
Driving Safety

Static Object (2D Map)
Moving Object (2D Trajectory)

Camera

Software Design

ICRA08, IV08

ICRA09
Processor 2
SLAM with MODT

GPS+IMU

Horizontal Laser Scanner
Static Objects (Black)
Host Vehicle (Green)
Moving Objects (Color)
Fusion with Video

Objects

- person
- bicycle
- group
- car

Laser Points

- moving
- seed
- group
Laser scanner $q$ measured at time $k_i$

Laser scanner $p$ measured at time $k_j$

Sensor geometry

Vehicle’s body frame at time $k_i$

Vehicle’s body frame at time $k_j$

Global Coordinate System

Vehicle pose $T_{vw}^{(k_i)}$

$Q = \{q_w\}$

$P = \{p_w\}$
A single object might be measured by different sensors at different time instance.
Laser scanner $q_i$ measured at time $k_i$

Sensor geometry $T_{qv}$

Vehicle's body frame at time $k_j$

Laser scanner $p$ measured at time $k_j$

$T_{pv}$

Vehicle pose $T_{vw}^{(k_j)}$

POSSIBLE for data association

Global Coordinate System

IMPOSSIBLE for data association

$\mathcal{Q} = \{q_w\}$

$P = \{p_w\}$
Sensor Calibration

- Sensor geometries are calibrated by minimizing the displacement between geo-referenced data sets of **non-rigid geometry**

- Two sequential steps
  - Horizontal Registration
  - Vertical Registration
Vertical elements → Horizontal registration

Ground data → Vertical registration
Horizontal Registration

2D map by the SLAM of L1

Vertical elements of L4
Vertical Registration

Ground elevation map by L3

Elevation difference map of L3 with L4+L5
Conclusion

- Towards an intelligent vehicle of Omni-directional eyes looking at the environment of both static and dynamic objects.

Welcome to our demonstration!
Thank you!

Contact Info:

Huijing Zhao
zhaohj@cis.pku.edu.cn
Peking University