Intelligent Robots Practice

Introduction

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Intelligent Robots Lab. (IRL)

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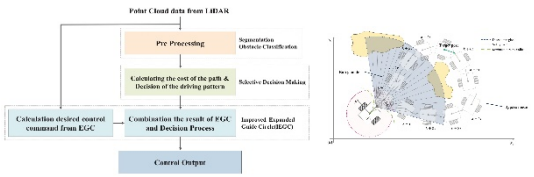
Chungbuk National University

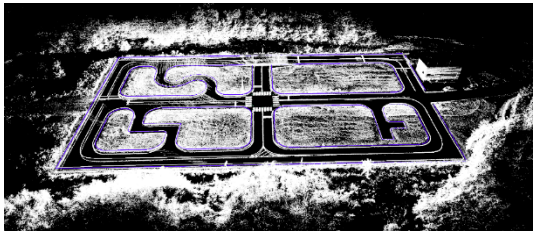
Intelligent Robots Lab. @ CBNU

- Autonomous Mobile Robots
  - Autonomous Navigation
    - Robot Motion Planning (Global/Local)
  - Localization and Mapping
    - Localization, VINS, etc
    - SLAM (Simultaneous Localization And Mapping)

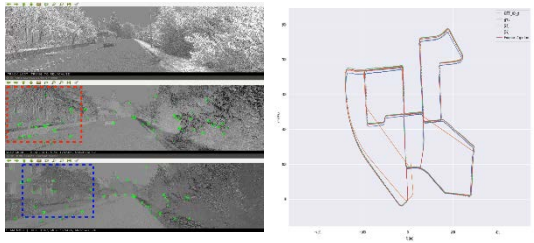
자율주행 경로계획 및 장애물 회피 주행 기술



LiDAR 기반 동시 위치추정 및 지도작성(SLAM) 기술

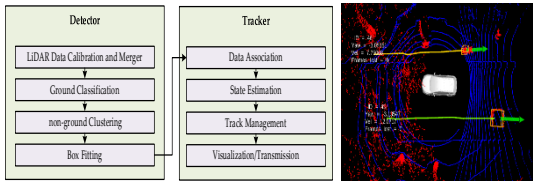


조명, 환경 변화에 강인한 동시 위치추정 및 지도작성(SLAM) 기술



물류자동화 AGV 관련 기술개발: SLAM, 자율주행 및 도킹 기술

자율주행을 위한 차량, 보행자 검출 및 추적 기술

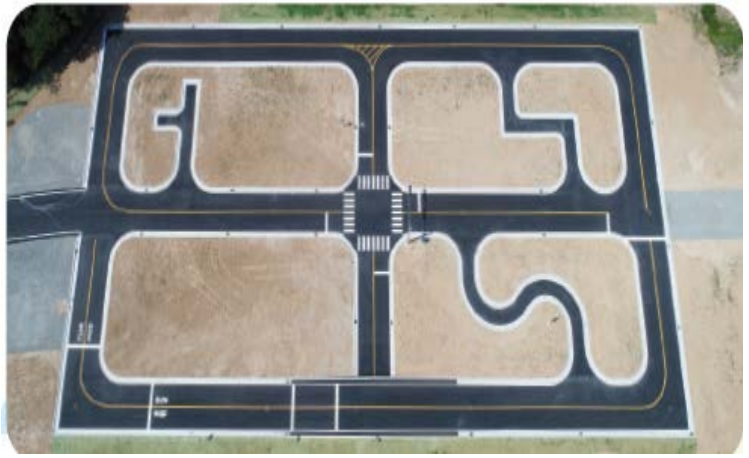


다중센서융합 및 캘리브레이션 기술

Intelligent Robots Lab. @ CBNU

- Vehicles and Infrastructure

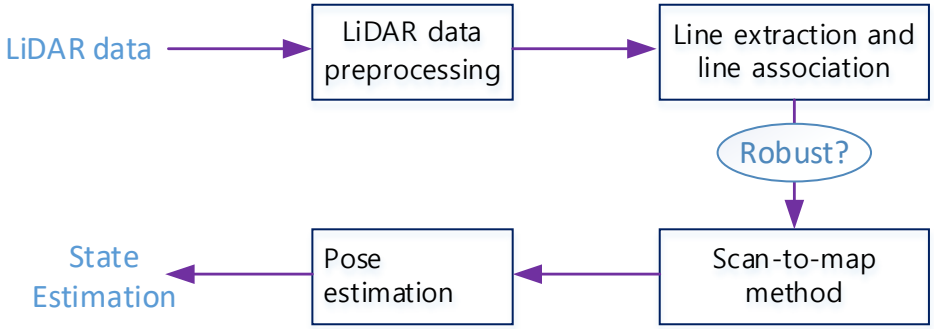
Autonomous Vehicles

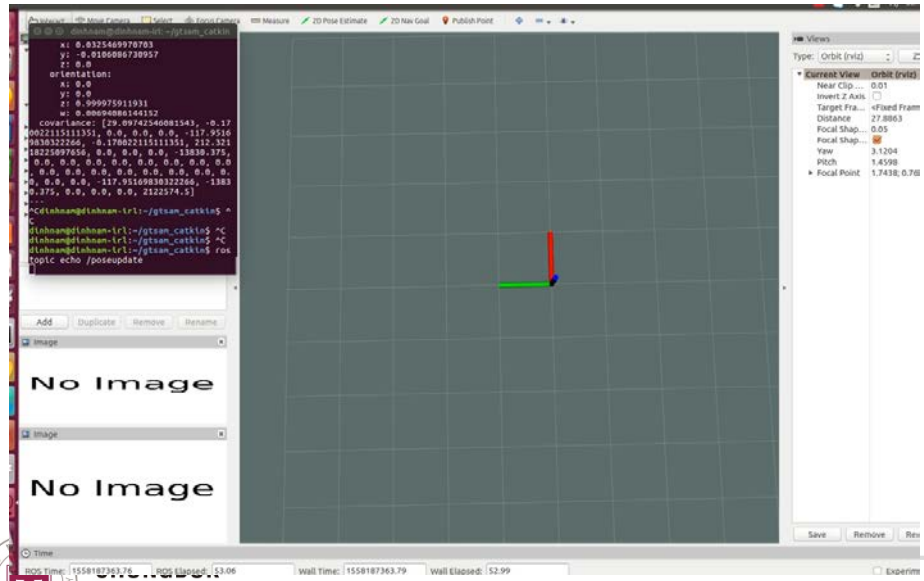


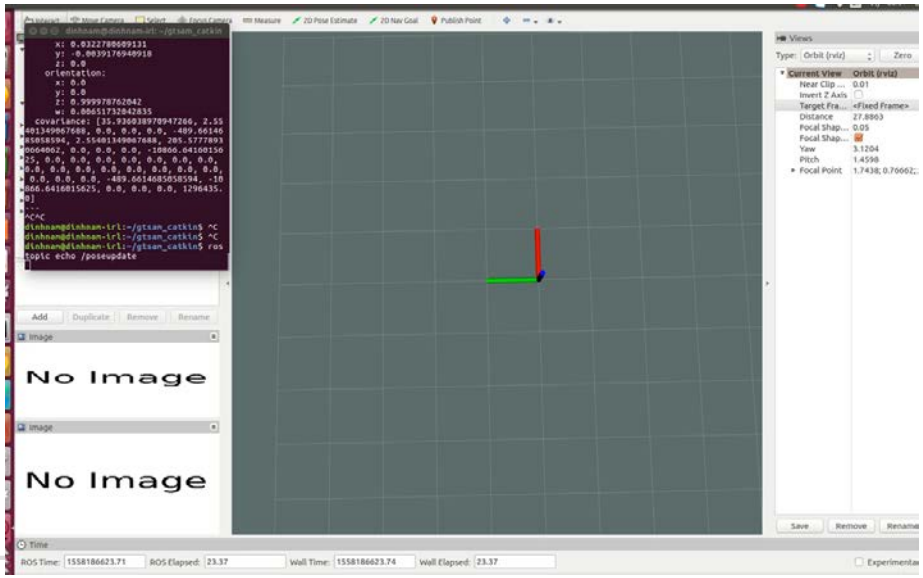
Testbed for Autonomous Vehicles
(about 10,000m^2)

2D LiDAR Odometry

- Efficient 2D LiDAR odometry using geometric primitives
  - Line feature extraction and association algorithm
  - Accurate LiDAR odometry algorithm using line feature-aided scan-to-map matching
  - Pipeline for LiDAR odometry
    - LiDAR data preprocessing
    - Line feature extraction and line association
    - Pose estimation

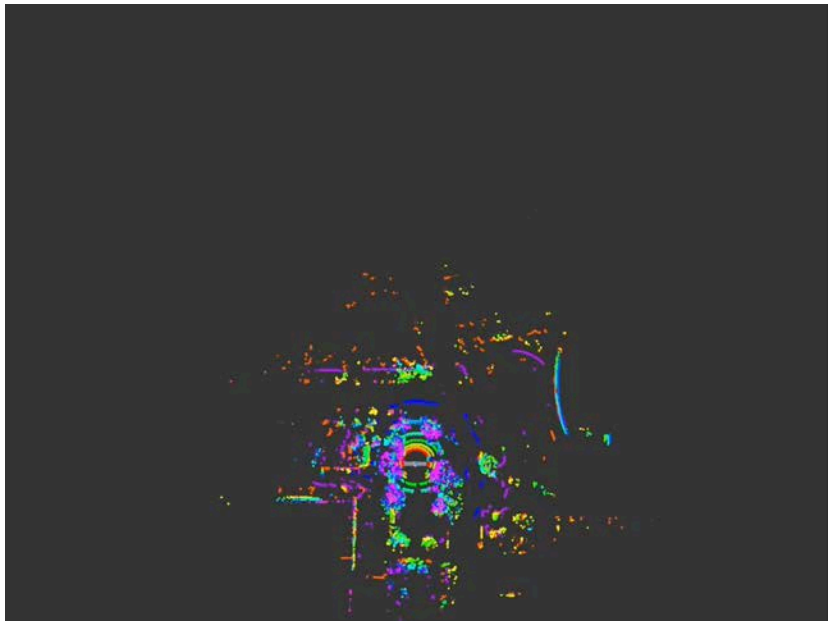






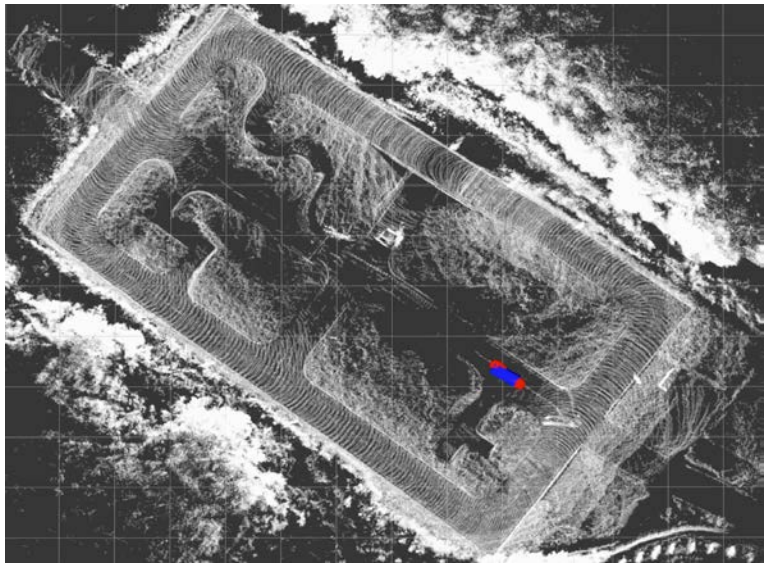
3D LiDAR based GraphSLAM

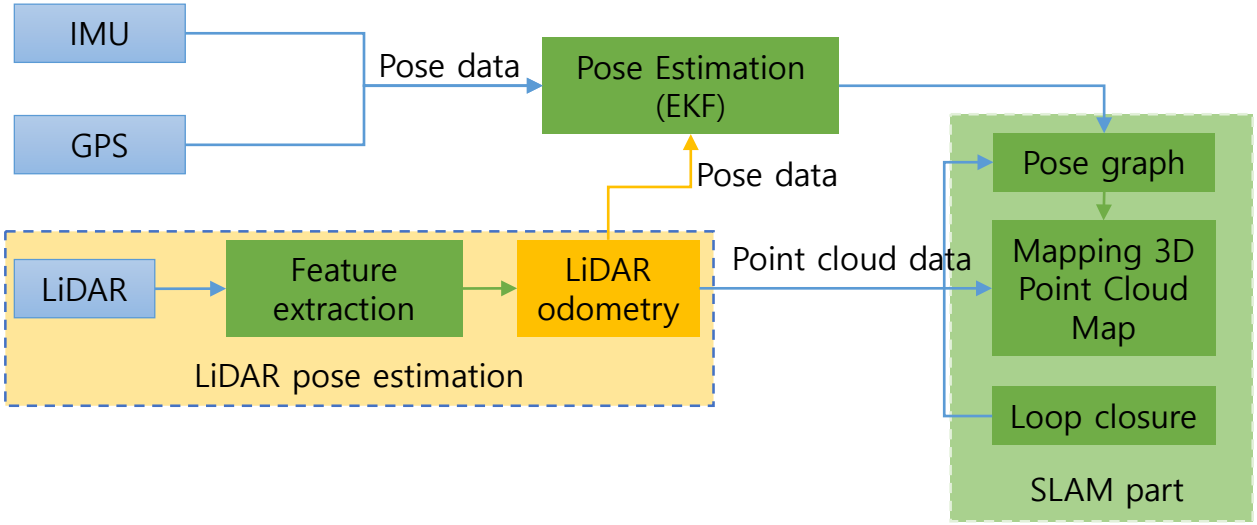
- 3D LiDAR point cloud data based GraphSLAM
  - Experimental Results



Sensor Fusion based SLAM/Localization

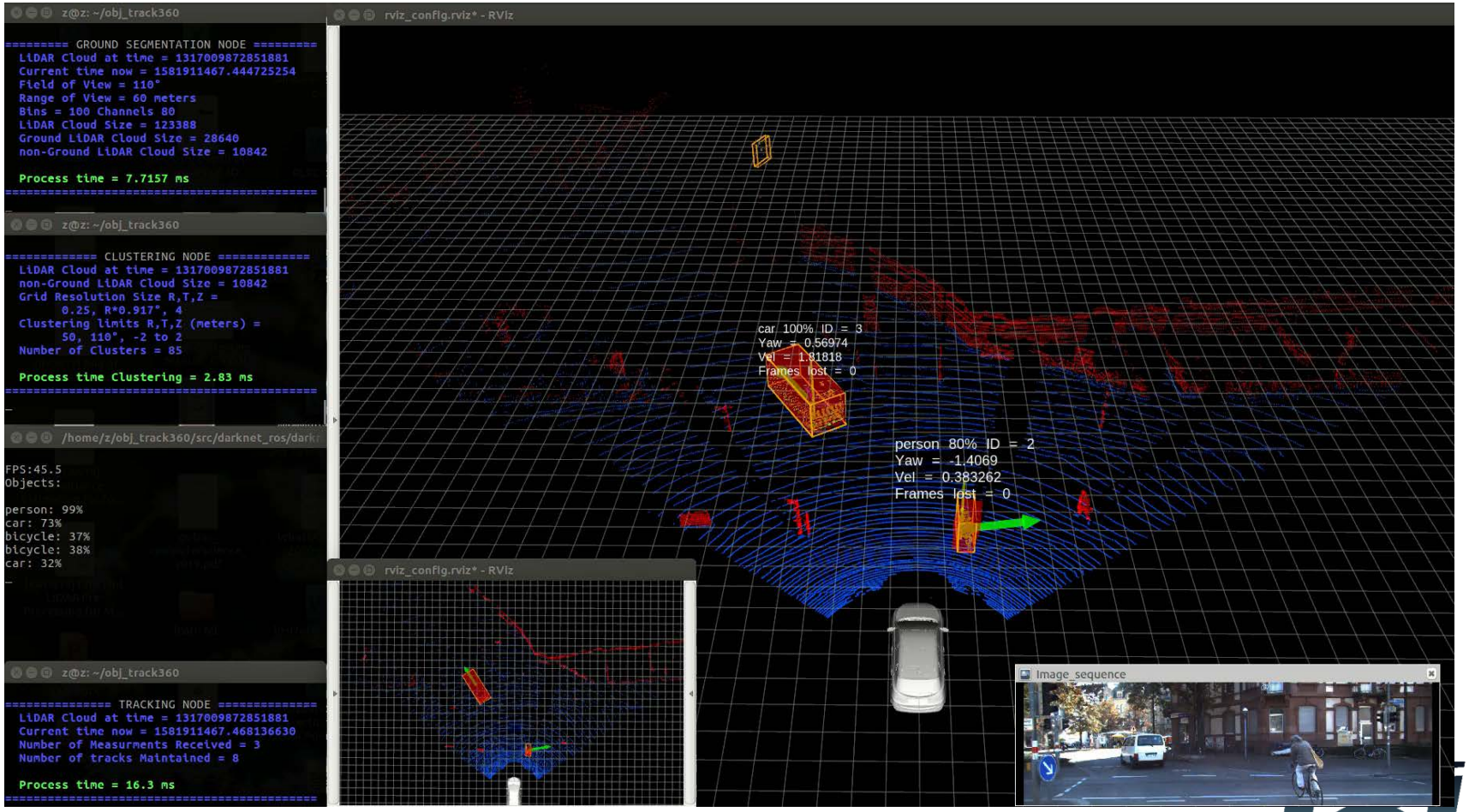
- Sensor Fusion based SLAM/Localization
  - LiDAR, GPS, IMU sensor fusion
  - Robust LiDAR feature detection
    - Corner, blob feature detection and mapping
  - SLAM and Accurate Localization based on EKF





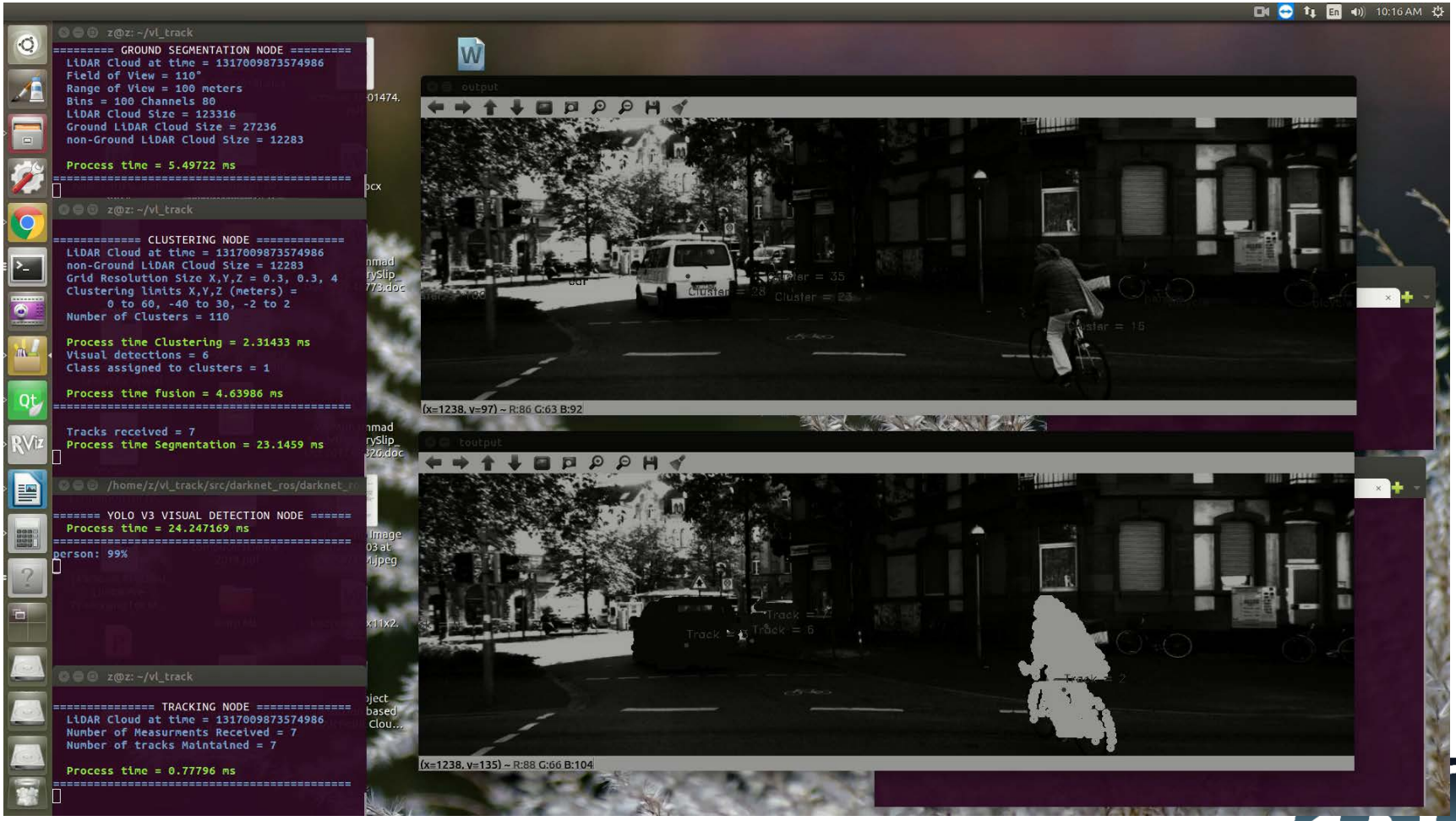
LiDAR based MODT

- MODT(Multiple Objects Detection and Tracking)
  - 3D LiDAR based MODT



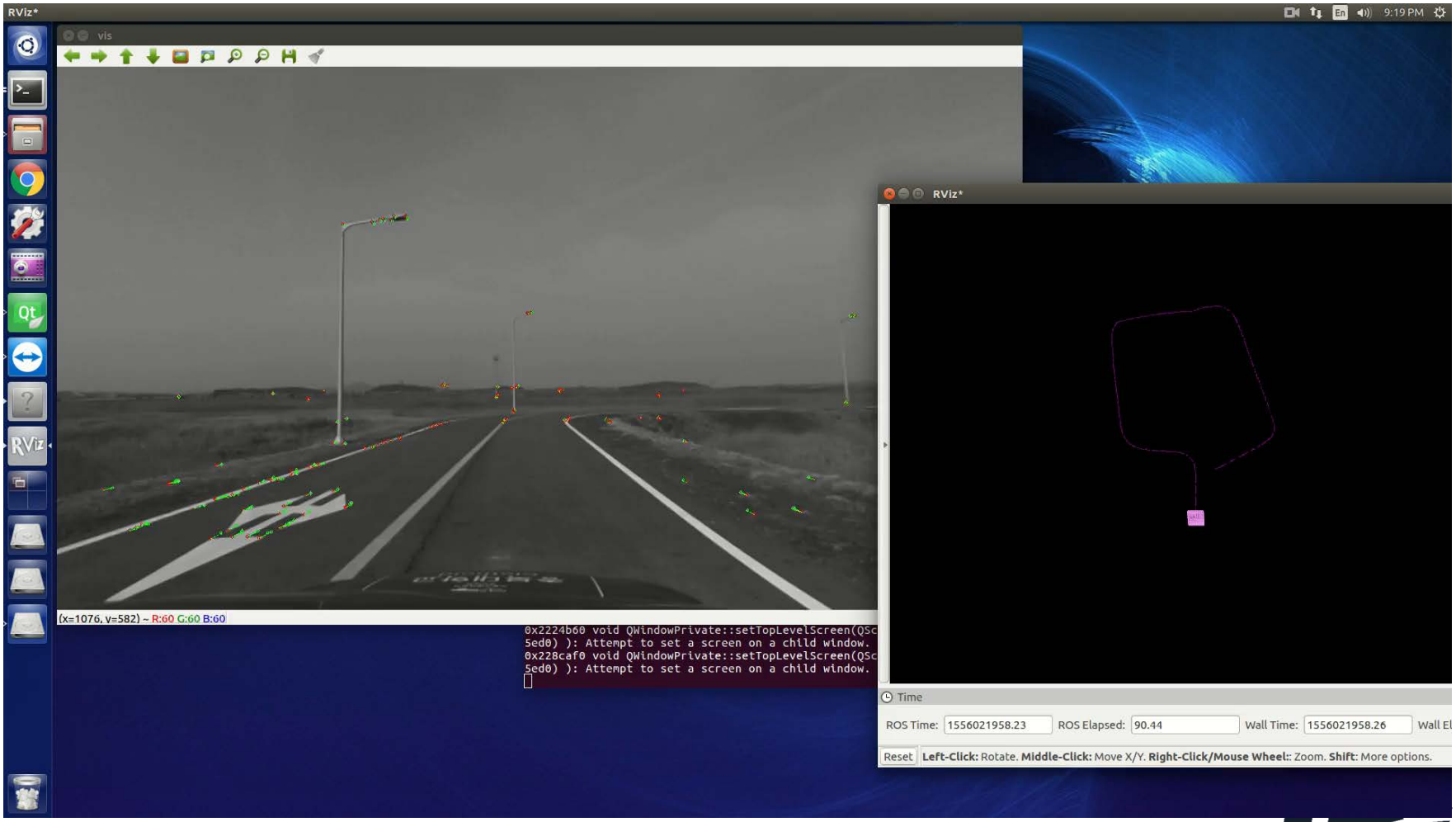
LiDAR based MODT

- MODT(Multiple Objects Detection and Tracking)
  - 3D LiDAR and Camera Fusion based MODT



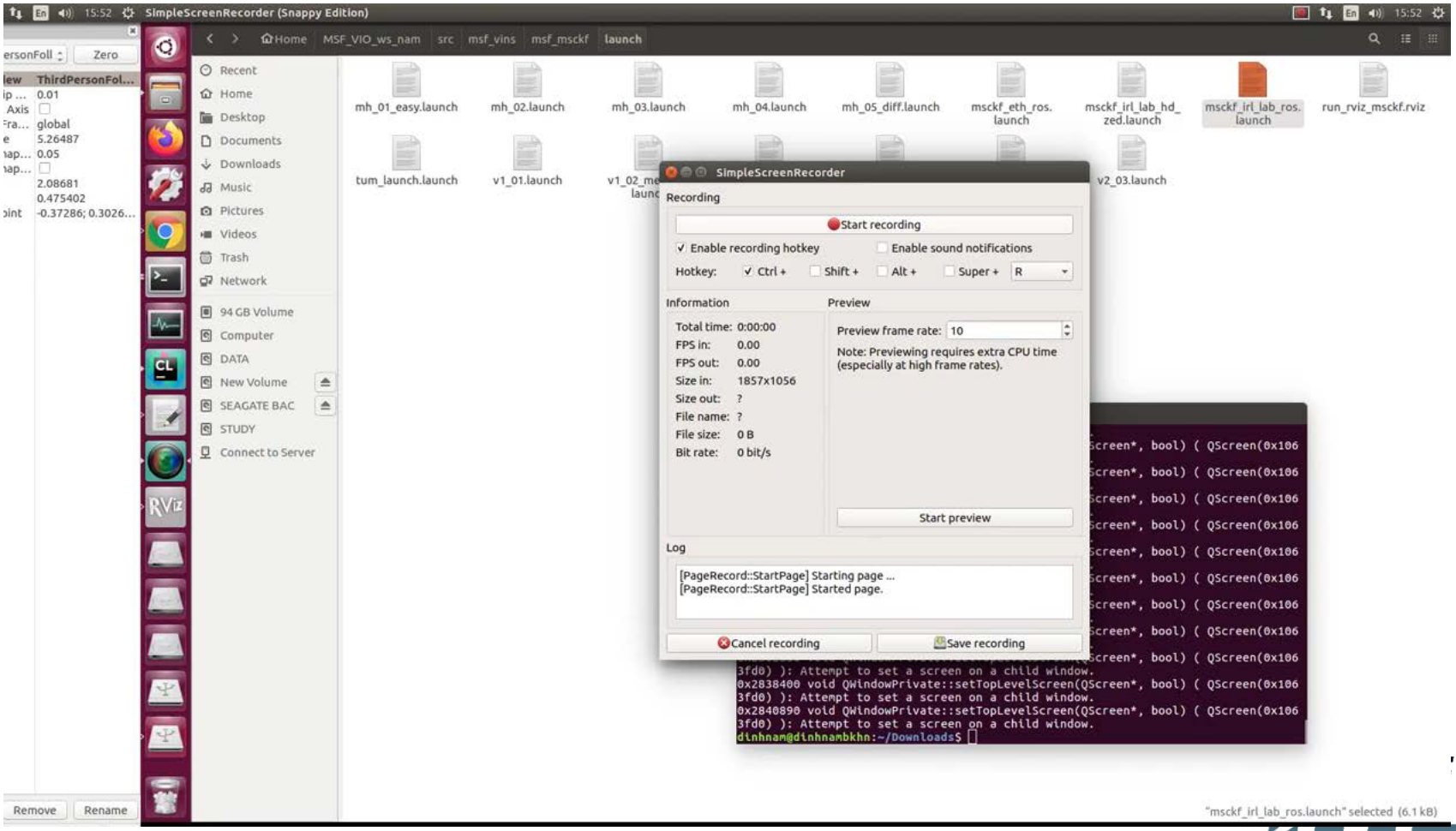
Stereo Visual Odometry

- SOFT based Stereo Visual Odometry



Multi-Sensor Fusion based SLAM

- Stereo Vision-Aided Inertial Navigation System in Dynamic Environments



Autonomous Vehicle

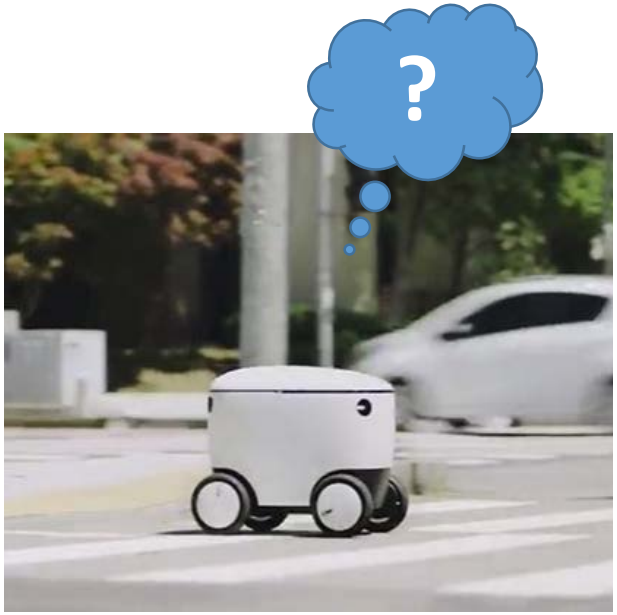
- Autonomous Vehicle
  - CBNU Clothoid (현대자동차 경진대회, 2019)

Autonomous Mobile Robots

Introduction

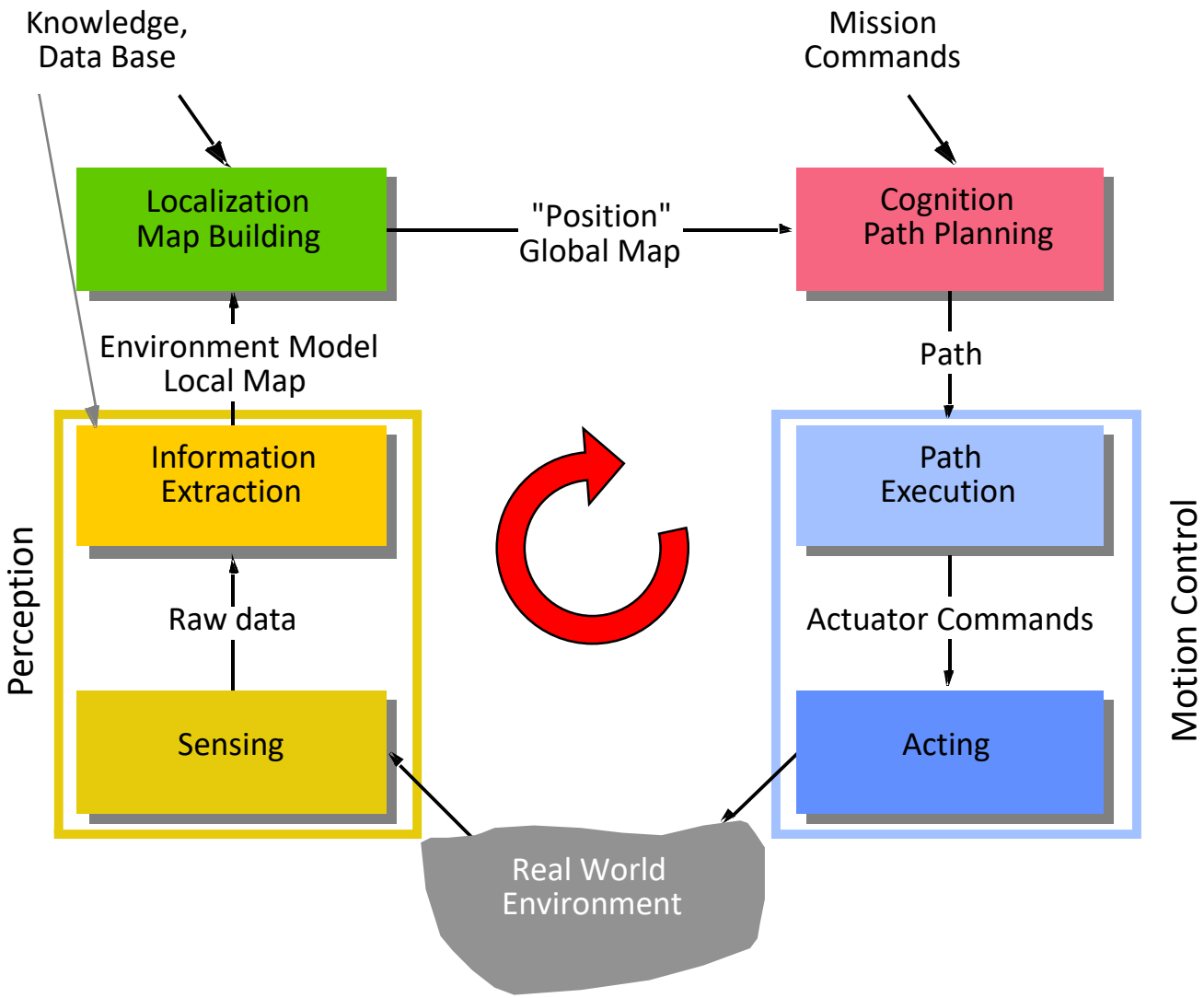
Key Questions and Concepts in Autonomous Mobile Robotics

- The three key questions in Mobile Robotics
  - Where am I ?
  - Where am I going ?
  - How do I get there ?



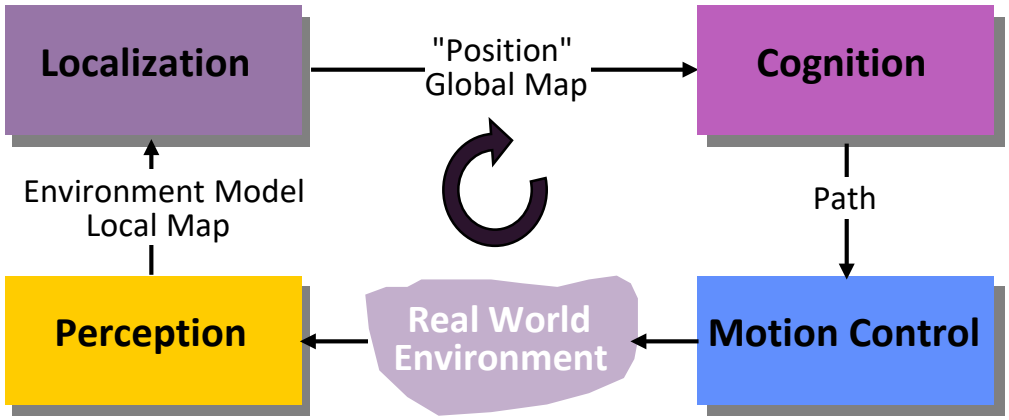
- To answer these questions the robot has to
  - have a model of the environment (given or autonomously built)
  - perceive and analyze the environment
  - find its position/situation within the environment
  - plan and execute the movement

Generic Control Scheme for Mobile Robot Systems

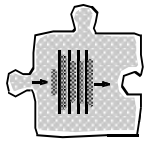


Control Architectures / Strategies

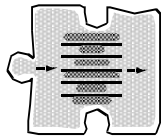
- Control Loop
  - dynamically changing environment
  - no compact model available
  - many sources of uncertainty



- Two Approaches
  - Classical AI
    - complete modeling
    - function based
    - horizontal decomposition



  - New AI, AL
    - sparse or no modeling
    - behavior based
    - vertical decomposition
    - bottom up

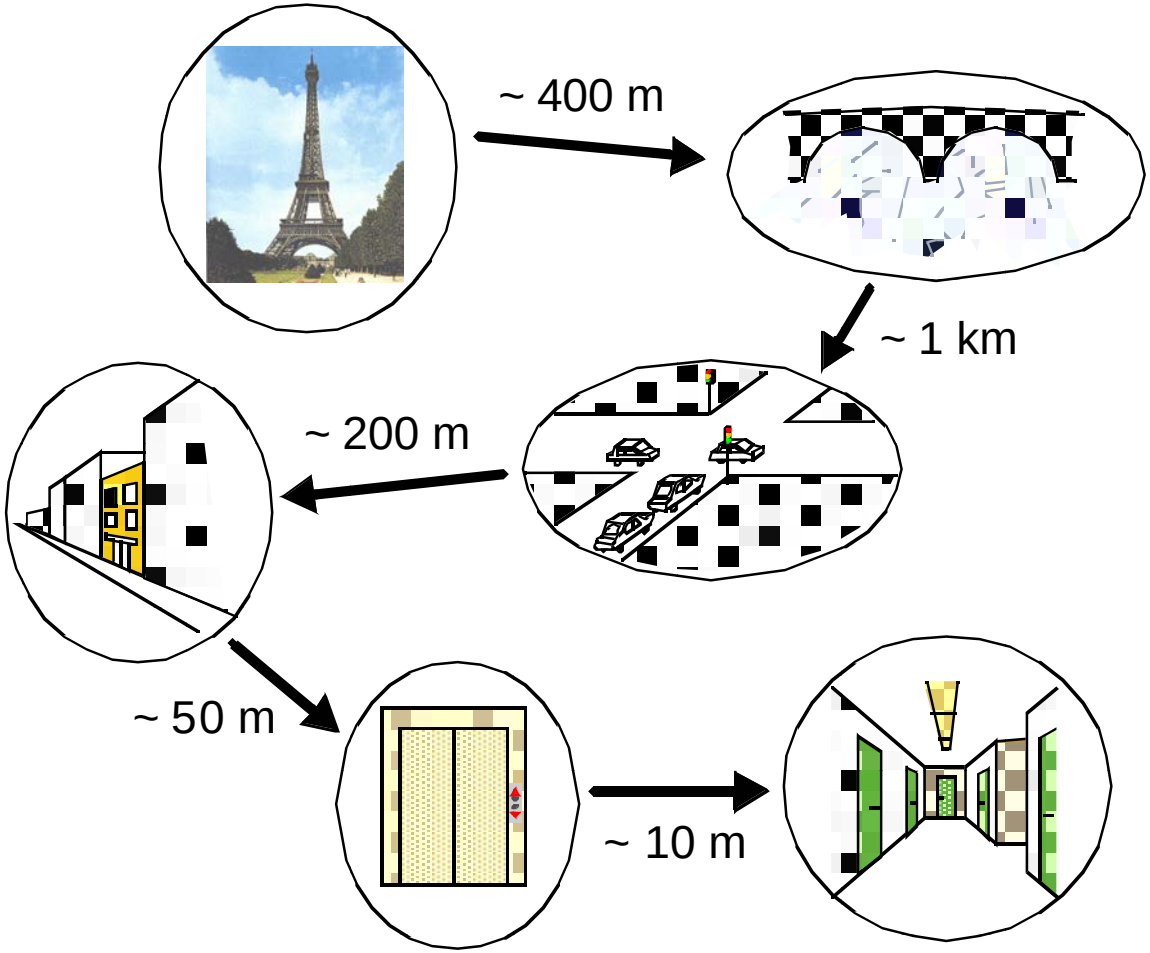


Environment Representation and Modeling

- Environment Representation
  - Continuous Metric → x,y,θ
  - Discrete Metric → metric grid
  - Discrete Topological → topological grid
- Environment Modeling
  - Raw sensor data, e.g. laser range data, grayscale images
    - large volume of data, low distinctiveness
    - makes use of all acquired information
  - Low level features, e.g. line other geometric features
    - medium volume of data, average distinctiveness
    - filters out the useful information, still ambiguities
  - High level features, e.g. doors, a car, the Eiffel tower
    - low volume of data, high distinctiveness
    - filters out the useful information, few/no ambiguities, not enough information

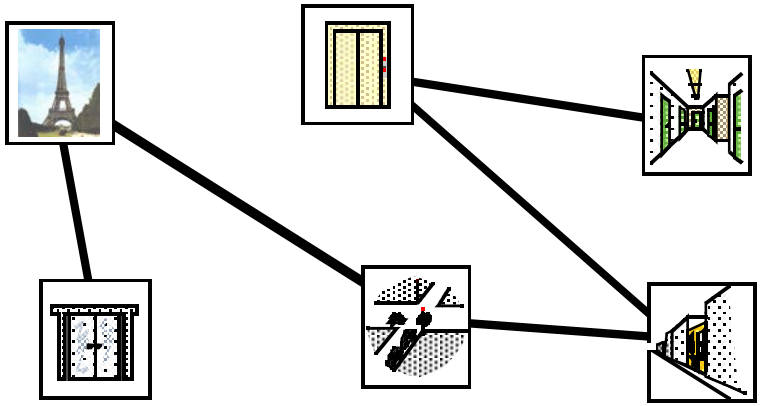
Environment Representation and Modeling

- Human Navigation
  - Topological with imprecise metric information

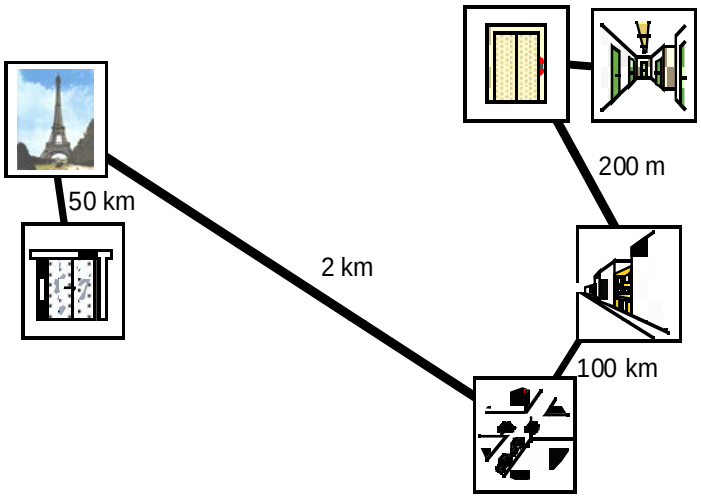


Environment Representation and Modeling

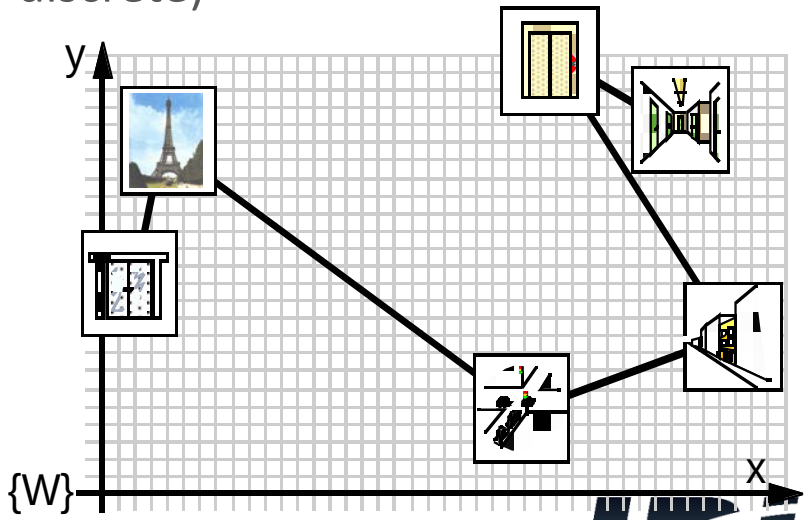
- Topological Maps (Recognizable Locations)



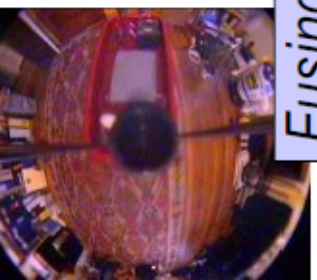
- Metric Topological Maps



- Fully Metric Maps (continuous or discrete)



From Perception to Understanding



Fusing & Compressing Information

Places / Situations
A specific room, a meeting situation, …

Servicing / Reasoning

- Functional / Contextual Relationships of Objects
  - imposed
  - learned
  - spatial / temporal/semantic

Objects
Doors, Humans, Coke bottle, car , …

Interaction

- Models / Semantics
  - imposed
  - learned

Features
Lines, Contours, Colors, Phonemes, …

Navigation

- Models
  - imposed
  - learned

Raw Data
Vision, Laser, Sound, Smell, …