Seamless Robot Localization and Navigation in Indoors-Outdoors for Logistics in Warehouses

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Context

- Project **TITAM-ie** to introduce an **autonomous robot** into a **indoors-outdoors warehouse** for transportation tasks
- Extra challenge: **The scenario cannot be adapted** for the robot and it will be shared with human activity
- Our contribution:
  - The robot is **always localized** seamlessly integrating several sensors depending on the availability and quality
  - The robot can **autonomously navigate** between any two points of the warehouse, including **maneuvers** to turn around and to avoid unexpected obstacles
Localization

**Indoors**: laser scan sensor + map + particle filter

**Outdoors**: Differential GPS + EKF

4x 400m loop in 40 minutes
Localization

- **Differential GPS** provides a position estimation with an **error of just few centimeters**
- Orientation uncertainty bounded (3° – 22°)
- During GPS shadows, only odometry is considered
Localization

- **Smooth transitions** using the door as a landmark and GPS quality
Navigation

- Car-like reactive **obstacle avoidance**
Navigation

.**Maneuvering** in cluttered spaces that **does not** require **planning**
Conclusions

- **Autonomous robot** successfully introduced into a warehouse for **transport tasks**
- Robust **indoor-outdoor localization**
- **Smooth transitions** in-out of the map
- **Safe navigation** in cluttered and open spaces
- Reactive **maneuvering** (no planning needed)

Thank you!