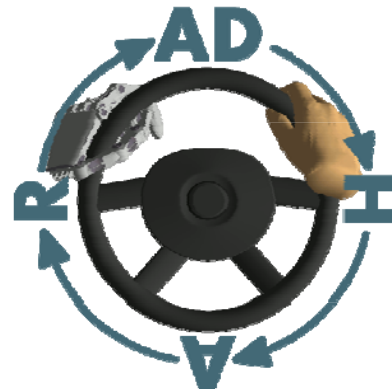


# RADHAR: Robotic Adaptation to Humans Adapting to Robots



[www.radhar.eu](http://www.radhar.eu)

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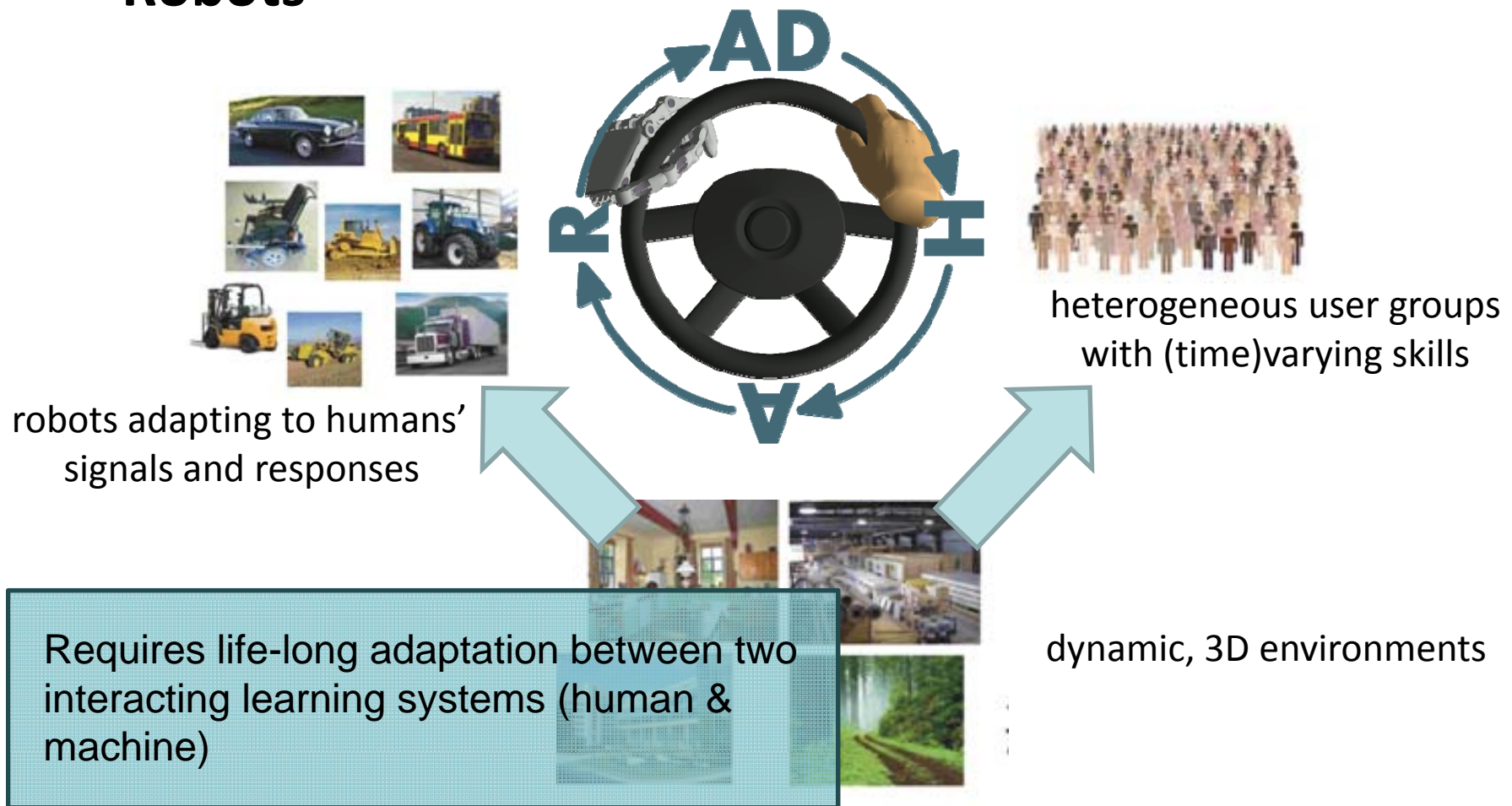
# Outline

- 1. What is RADHAR?**
- 2. Current state of RADHAR**
- 3. Conclusions and future work**



# 1. What is RADHAR?

- **Vision: Robotic ADaptation to Humans Adapting to Robots**

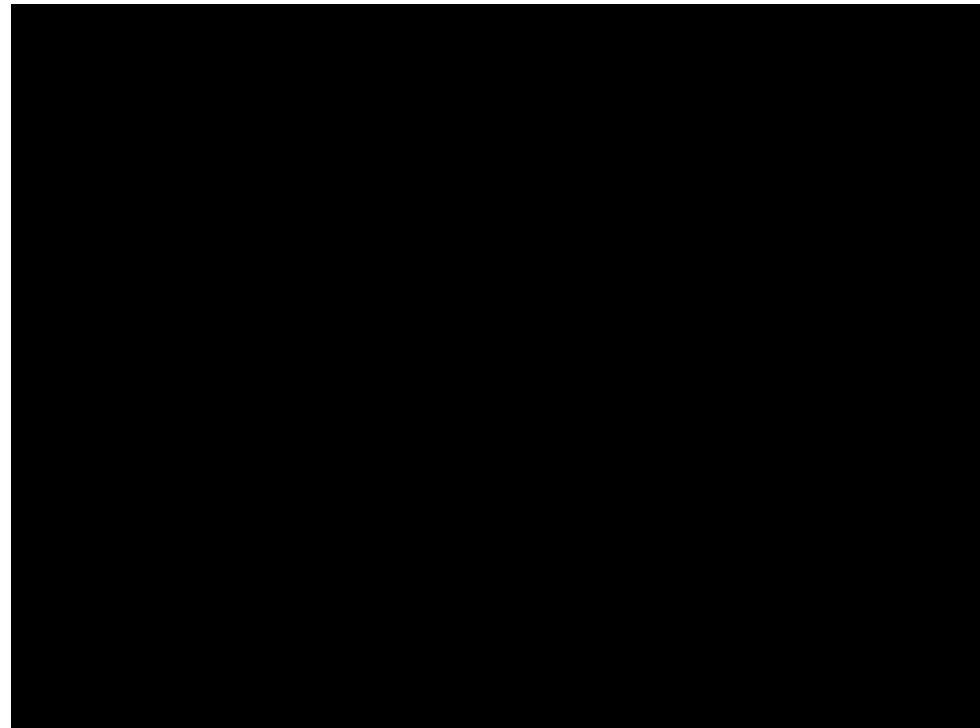




# 1. What is RADHAR?

## ■ Concrete application domain: wheelchair navigation assistance

- Difficulties performing common manoeuvres: avoiding obstacles, driving through doorways, docking at tables
- Danger when moving to more complex environments: crowds, outdoors, 3D
- Representative for target public: varying skills and abilities





# 1. What is RADHAR?

- **Expected contributions:**
  - Online 3D environment perception at 10 Hz
    - local map construction
    - traversability analysis
    - Detection & prediction of dynamic obstacles
  - Driver perception
    - vision (attention, posture...)
    - haptic interaction
    - online user modelling
  - Plan recognition (intention estimation)
  - Shared control decision making at 5 Hz
  - Design and implementation of a repeatable benchmark test to evaluate driver navigation assistance system



# 1. What is RADHAR?

## ■ Consortium:

### 2 user groups

NMSC, Nationaal Multiple Sclerosis Centrum V.Z.W.



Windekind,  
school for  
children with  
disability



### 1 research institute

KATHOLIEKE UNIVERSITEIT  
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### 3 universities



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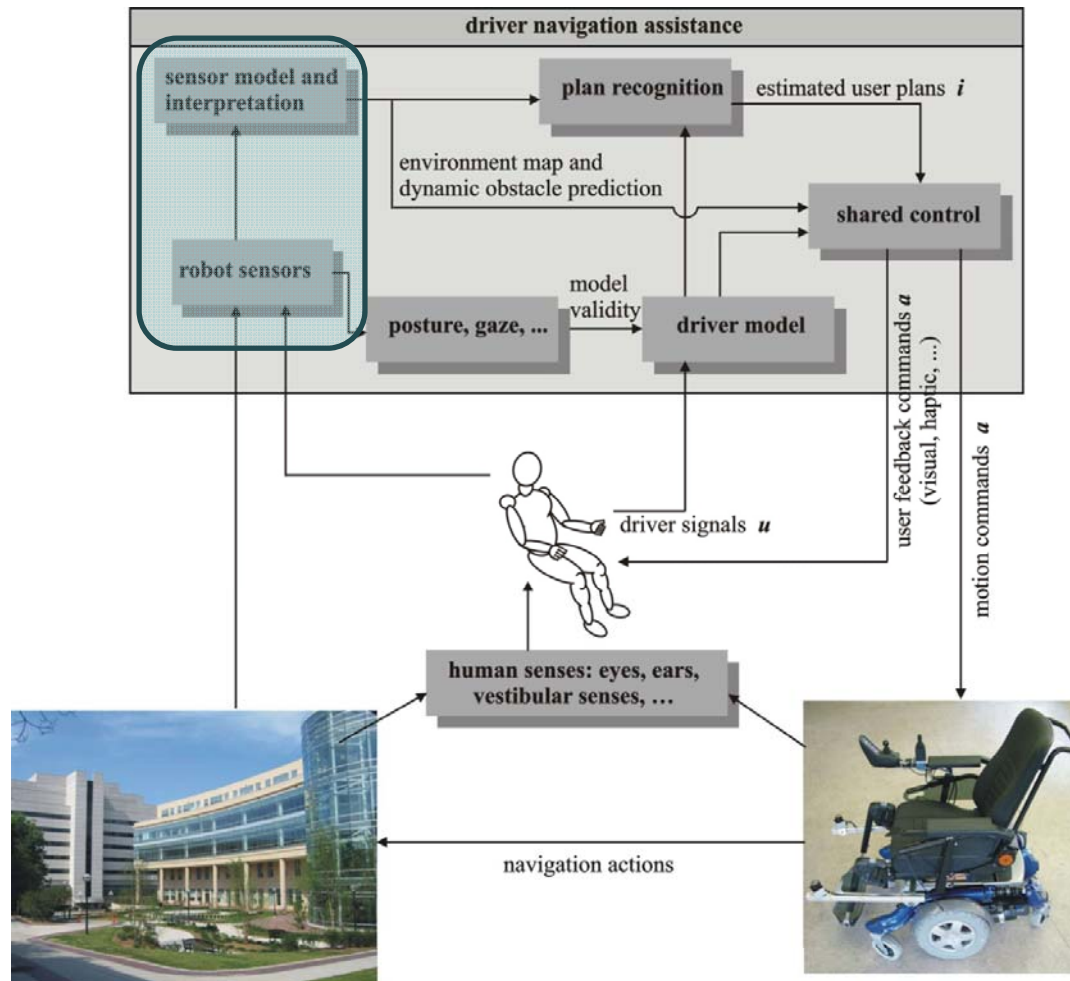


### 3 companies



## 2. Current status of RADHAR

- General overview of RADHAR framework



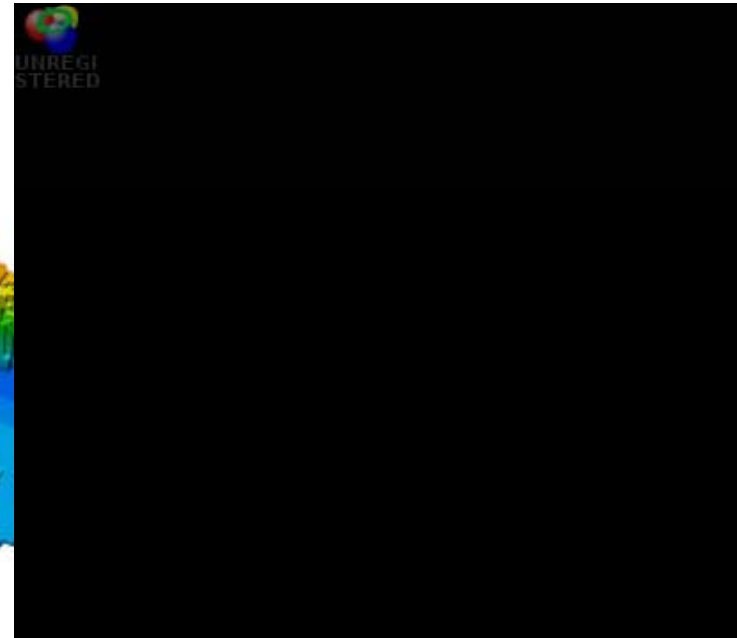
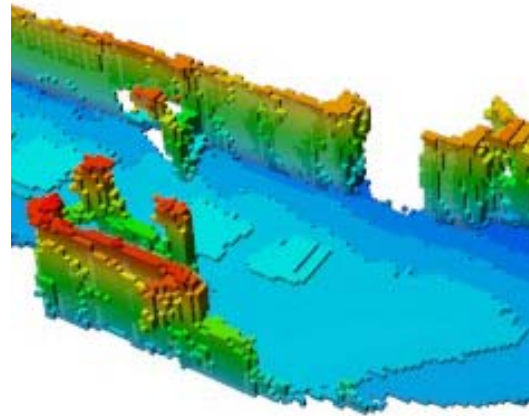


## 2. Current status of RADHAR

### ■ Environment perception

#### — SLAM

- Input: sensor data (cameras, laser, odometry, imu)
- Determine relative offset of sensor poses
- Integrate multiple sensor readings into a map
- Open source library „OctoMap“ (OctTree)

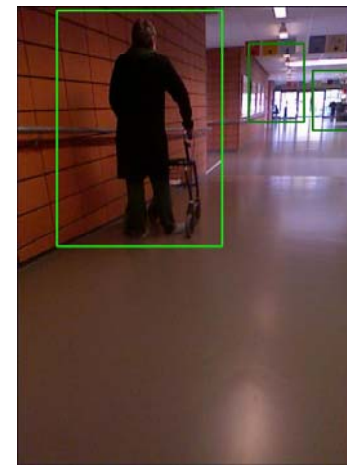
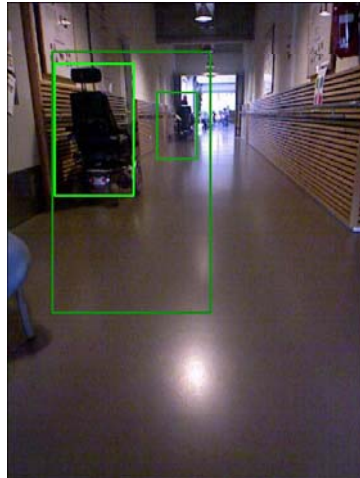
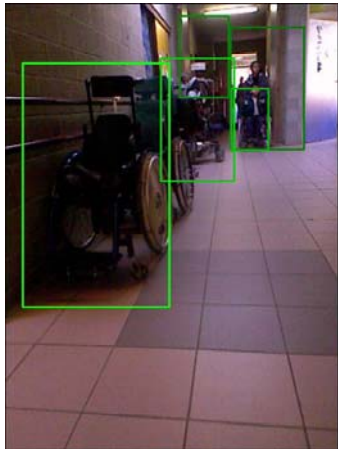






## 2. Current status of RADHAR

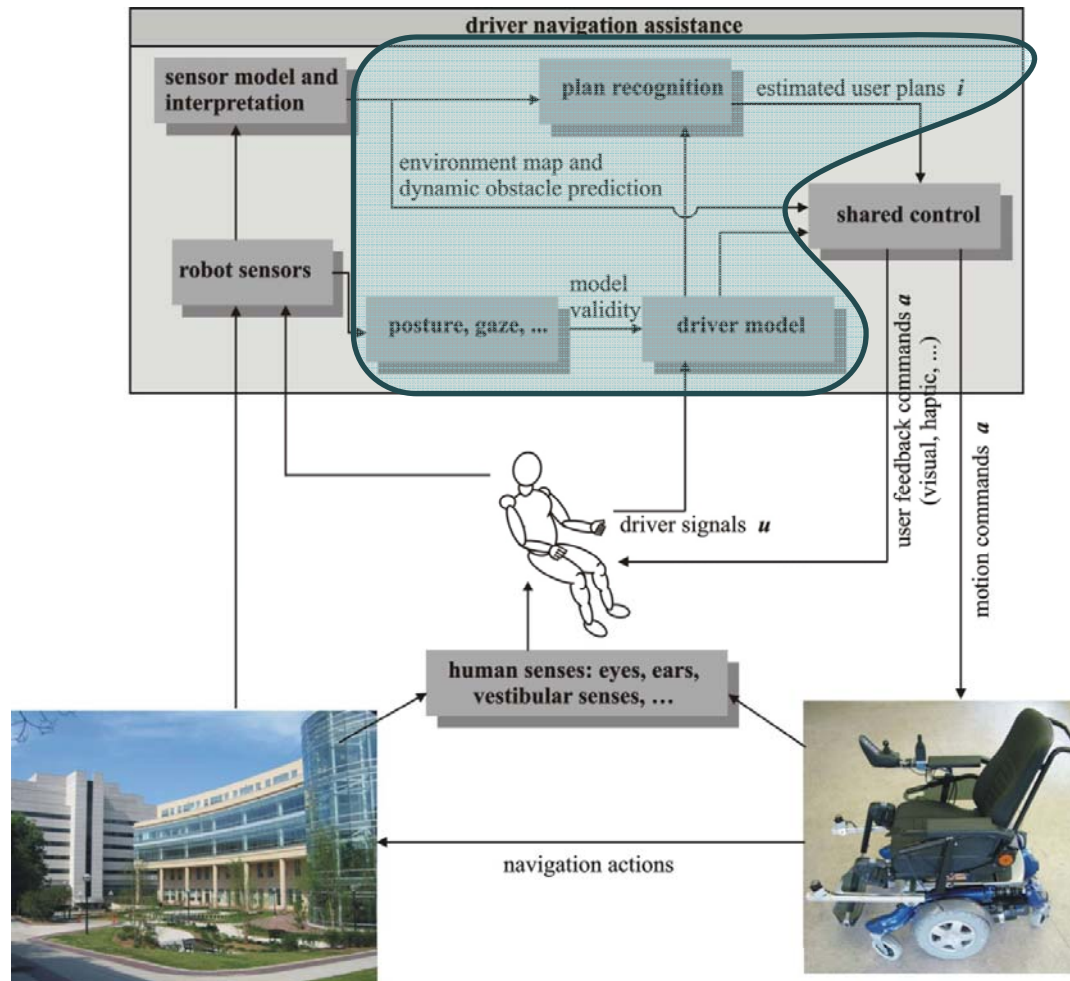
- **Environment perception**
  - Detection of dynamic obstacles
    - People
    - Wheelchairs
    - Dogs





## 2. Current status of RADHAR

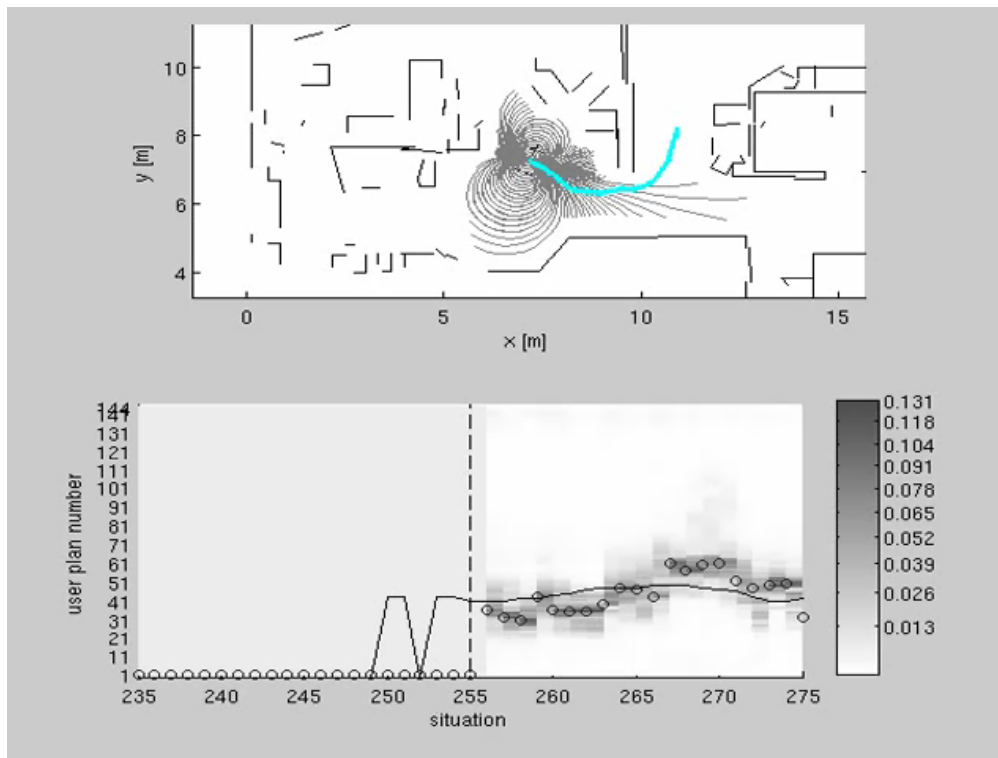
- General overview of RADHAR framework





## 2. Current status of RADHAR

- **Driver perception**
  - Driver modelling and plan recognition



Recognizing navigation plans:

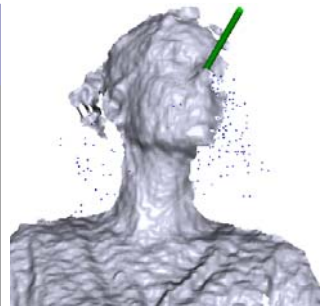
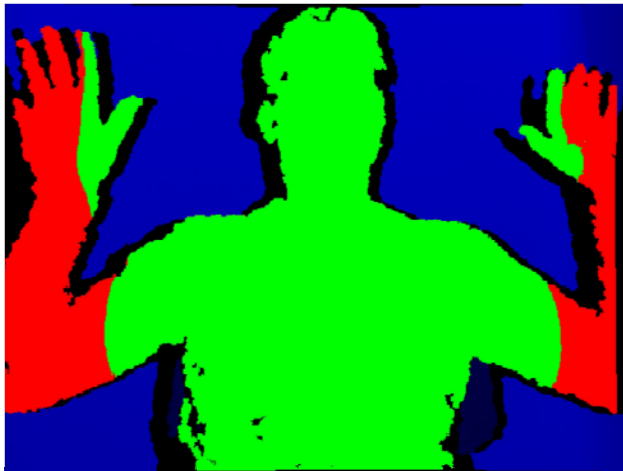
1. Generate all possible safe trajectories (plan generation)
2. Consider user's driving abilities (user modeling)
3. Combine present and past driving information (temporal reasoning)



## 2. Current status of RADHAR

### ■ Driver perception

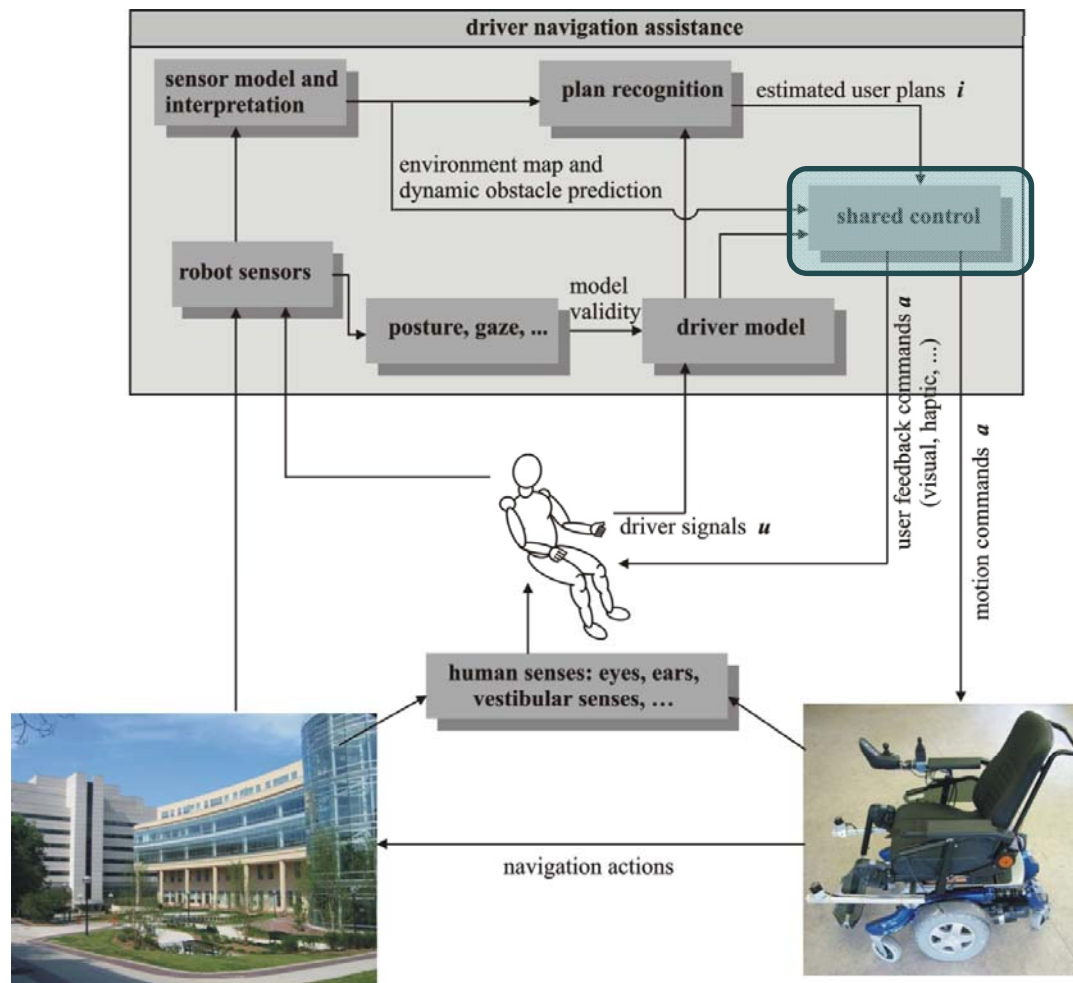
- Human body and attention modelling
  - Human Body Detection and safety volume check
  - 3D Head Detection and Pose Estimation
  - Eye Detection





## 2. Current status of RADHAR

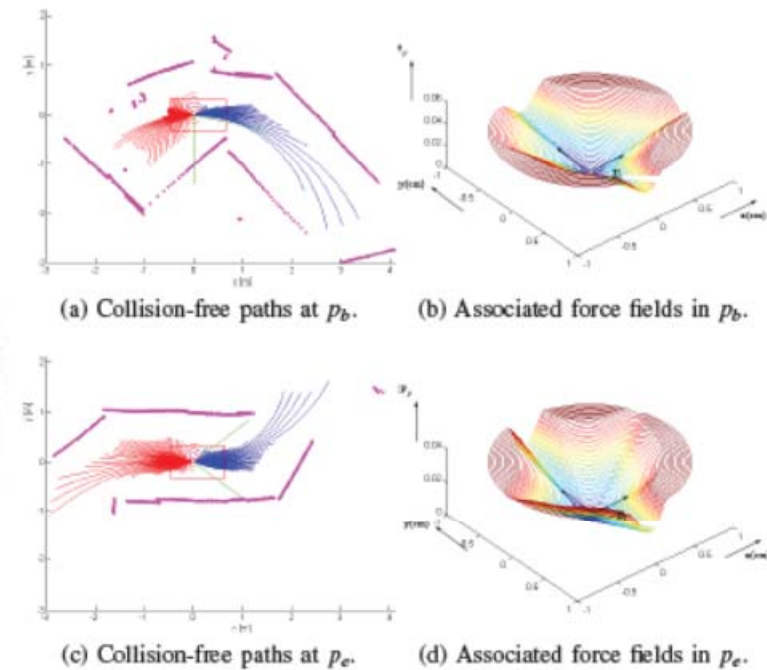
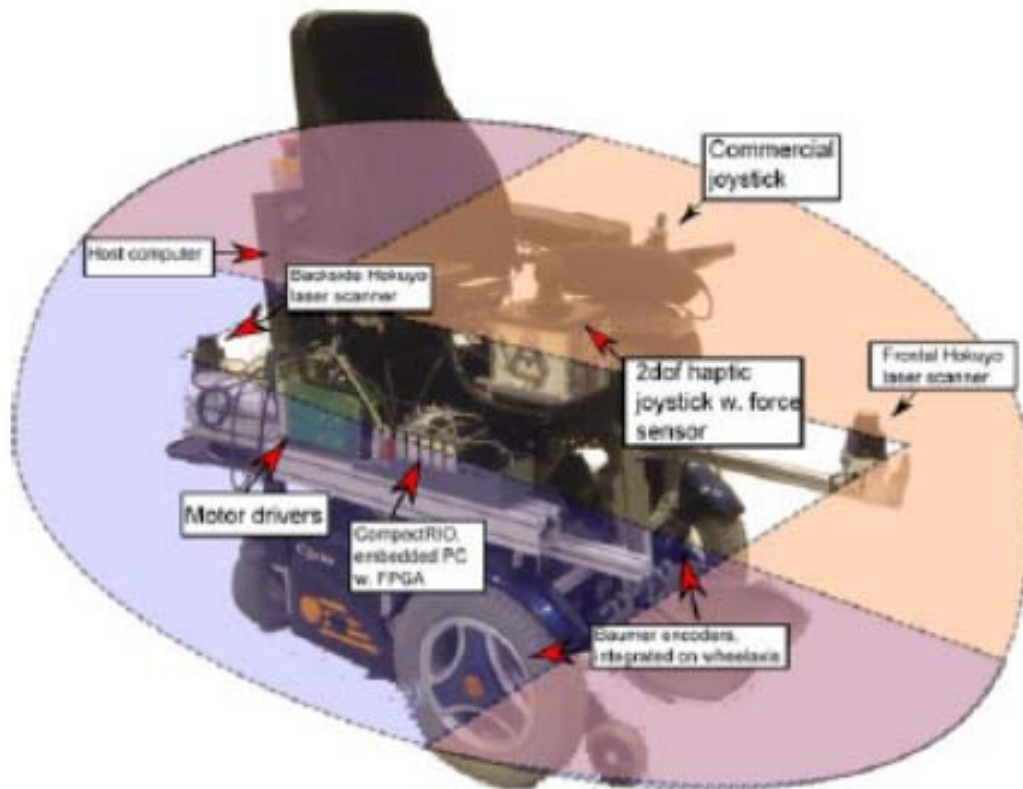
- General overview of RADHAR framework





## 2. Current status of RADHAR

- **Shared control: haptic joystick**
  - Fast bilateral communication channel





## 3. Conclusions and future work

- **Iterative evaluation by user groups**
- **Integration of modules**
  - Trajectories that consider dynamic obstacles
  - Incorporation of attention information
- **Shared control**
  - Integration of intention estimation with haptic control
  - Use of probabilistic decision making POMDP



## 3. Conclusions and future work

- **Robotic ADaptation to Humans Adapting to Robots**
  - Life-long adaptation between two interacting learning systems (human & machine)
  - Heterogenous wheelchair user population, driving in dynamic and populated environments
- [www.radhar.eu](http://www.radhar.eu)

