SnT Automation & Robotics Research Group
- Mobile Robotics Research at SnT -

Prof. Dr.-Ing. Holger Voos

• founded in 2009

• Figures:
  - 20 faculty members, >300 researchers & staff
  - 20 Mio € annual budget
  - 100 Mio € third-party funding acquired since start!

• Objectives:
  • **Part of Luxembourg’s infrastructure** (human resources, education/training, research, development, tech transfer) improving competitiveness
  
  • **Centre of excellence** – internationally leading research and innovations in secure, reliable and trustworthy ICT systems and services
  
  • Play an instrumental role to **increase R&D investments in Luxembourg** leading to growth and ultimately to highly qualified employments
SnT strategy

• Impact-oriented research program (long-term / mid-term),
  strategic research areas:
  - Secure and Compliant Data Management
  - FinTech
  - Cybersecurity
  - Space Systems & Resources
  - Autonomous Vehicles
  - Internet-of-Things, Industry 4.0

• Target research areas through long-term strategic partnerships with national (industrial) partners
• Establish international collaboration (academic & industry)
• Recruit top scientists
• Offer highly competitive training (e.g. PhD candidates with partners)
• Support Tech Transfer, entrepreneurship
SnT Automation & Robotics Research Group

• Founded in 2012

• Main research priorities:
  - perception & control for autonomous vehicles & robots
  - distributed networked automation and control

• Team:  ≈ 20 researchers (PostDocs, PhDs), 2 technicians, MSc students

• Equipment in robotics:
  - Indoor UAV flight arena with motion capture system
  - partner in Nvidia Joint AI lab
  - partner in 360 Lab / Automated Driving Lab (1 Smart ED, 1 KIA Soul)
  - Space Robotics Lab (in 2019)
Autonomous Vehicles & Robots - Luxembourg perspective

- service robots
- connected & autonomous driving
- unmanned aerial vehicles
- space robots

- manufacturing
- logistics
- agriculture
- social robots
- health
- caretaking
- education
- energy-efficient driving
- connected driving
- automated driving
- surveillance
- inspection
- transport
- emergency
- on-orbit servicing
- space exploration
- space resources

Smart Cities

Smart Mobility

High Performance Computing (HPC)
## Autonomous Vehicles & Robots – Research Areas

### Research Areas, Methodologies:

#### Perception & Control:
- Sensor fusion, situation awareness
- Optimization-based control

#### Autonomie, Intelligence:
- Intelligent control, machine learning
- Distributed, cooperative control

#### Engineering Design:
- Systems and software engineering
- Simulation for autonomous systems
Autonomous Vehicles & Robots - Applications

Application Areas and Partners (I):

Unmanned Aerial Vehicles (Drones):
Autonomous operations, flying manipulation, aerial inspection
**Partners:** Army of Luxembourg, LuxConnect, Cargolux

Service and Social Robotics:
Social robots in public spaces, service robots in Industrie 4.0 and construction industry
**Partners:** City of Luxembourg, Neobuild

Driver Assistance, Autonomous Driving, e-mobility:
Energy-efficient automated driving for electric & hybrid cars, autonomous driving
**Partners:** Delphi Automotive, Volvo
Application Areas and Partners (II):

**Advanced Simulators for Autonomous Systems:**
Simulators for autonomous driving, Industrie 4.0, UAVs  
**Partners:** CBN Technologies

**Multi-Robot-Systems:**
Coordinated control of UAVs, multiple robots in Industrie 4.0  
**Partners:** LuxConnect, CBN Technologies

**Space Robotics:**
Systems engineering for microsatellites & new space services,  
space robots for debris removal, space resources / asteroid mining  
**Partners:** LuxSpace, ispace
Selected Areas: Sensor Fusion and Situational Awareness

- Sensor fusion for advanced situation awareness

  Example: solutions based on vision and LIDAR

- Semantic representation of complex dynamic environments

  Example: semantic representation for fast UAV path planning

- Localization and Mapping (SLAM) in extra-terrestrial environments

  Example: SLAM for Moon rover missions, cooperation with ispace Europe.
Selected Areas: Optimization-based Control

- Fast stochastic nonlinear model predictive control

![Diagram of semi-autonomous Eco-ADAS]

**Example:** energy efficient driving for electric vehicles

- Model predictive control for advanced manipulation

![Image of flying manipulation]

**Example:** control of flying manipulation

- Task-adaptive model predictive control

![Image of autonomous vehicle]

**Example:** autonomous start and landing, obstacle avoidance, ..
Selected Areas: Intelligent Control, Machine Learning

• Improved visual navigation and localization with deep learning
  Example: UAV localization in aerial inspection

• Detection & tracking of objects in complex scenarios using ML
  Example: detection & tracking of people and faces with UAVs

• Learning of Control Behaviours with reinforcement learning
  Example: flight control, flying manipulation