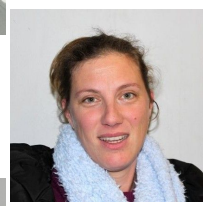
Thème Scientifique 3 : Hétérogénéité et Complexité

Journées du GdR Robotique 2024
5-6/11/2024

Co-chairs

- **Chedli BOUZGARROU** PU, Clermont Auvergne INP - SIGMA, Institut Pascal UMR 6602 - UCA/CNRS
  - Automation of complex tasks
  - Robot-process interactions
  - Synthesis, modeling, and control of mechanisms and robots
- **Cindy CAPPELLE** MCF, Univ.Lille, CRIStAL UMR CNRS 9189
  - Former co-chair of GT2 Mobile Robotics
  - Multi-sensor data fusion
  - Fault-tolerant localization and perception of mobile robots/vehicles
  - Air-ground cooperation
- **Karen GODARY-DEJEAN** MCF, LIRMM, Montpellier
  - Former co-chair of GT4 Control Architectures
  - Mission management, decision-making architectures
  - Reliability, fault tolerance
  - Modeling and formal verification
- **Charles LESIRE-CABANIOLS** DR, ONERA/DTIS, Toulouse
  - Former co-chair of GT4 Control Architectures
  - Software architectures, middleware, formal verification
  - Mission planning, decision-making architectures, multi-robot task allocation
- **Marco TOGNON** ISFP, INRIA/Rainbow, Rennes
  - Co-leader IEEE TC Aerial Robotics and UAVs
  - Aerial robotics
  - Manipulation
  - Multi-robot systems



Scientific Themes of TS3

Reliability and Safety:

- Fault tolerance / reliability / resilience:
  - From a software architecture perspective
  - From a hardware architecture perspective
- Management and consideration of uncertainties
- Diagnostics
- Redundancy and hyper-redundancy (for safety and also for completing complex tasks)

Multi-Robot and Robot-Infrastructure Cooperation:

- Multi-modality in mobile robotics (coordination of terrestrial, aerial, and marine robots)
- Multi-robot data fusion (notably for collaborative perception, localization, and mapping)
- Task decomposition, allocation, and distribution
- Optimization of collective performance, mission programming, and planning
- Communication and connectivity

Two Case Studies

Illustration of TS3 through 2 case studies:

- Heterogeneous multi-robot system in an open environment
- Complex manipulation in a controlled environment

Heterogeneous multi-robot system in an open environment

- **Complementarity** of movement or action modes of different platforms
  - aerial, terrestrial, maritime, etc.
  - with various sensors or effectors
- Required **autonomy**
  - system not operable by human operators
- Complex open **environment**
  - unstructured, unknown
  - disruption of localization systems (GNSS, atmospheric conditions, etc.) or communication
- Various **applications**
  - search and rescue, first aid
  - security
  - environmental observation/surveillance
  - inspection

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Heterogeneous multi-robot system in an open environment

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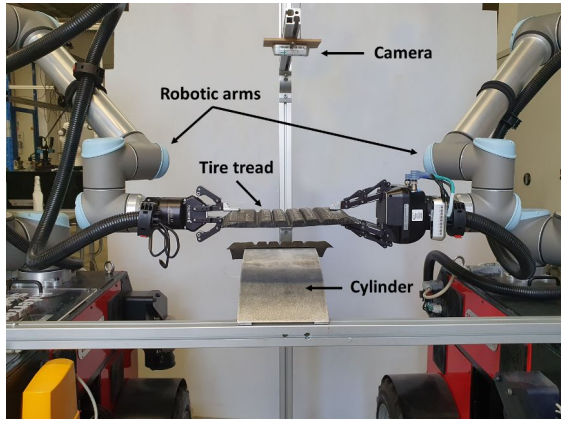
- **Reliability and Safety:**
  - Decision-making autonomy
  - Explainability, interaction with human operators
  - Reliability of the multi-robot system, resilience, fault tolerance
  - Software architectures and middleware for distributed, communicating systems
- **Multi-Robot and Robot-Infrastructure Cooperation:**
  - Safe multi-agent path planning
  - Robust distributed localization/SLAM
  - Robust multi-agent tracking
  - Co-manipulation
  - Task allocation

Complex manipulation in a controlled environment

- **Production Environments**
  - Synchronization of robots with other production machines
  - Partial or full automation of production
  - Product variability and changing operational conditions
- **Industrial Warehouses**
  - Conveyor systems
  - Storage, loading, unloading, machine supply
  - AGVs (Automated Guided Vehicles), mobile manipulators
- **Complex Processes**
  - Multi-robot and multi-process cells
  - Strong dynamic interactions between robot and process
  - Quality control and real-time adaptation of process parameters



Complex manipulation in a controlled environment

Reliability and Safety:

- Specification of robotic systems to meet reconfigurability, adaptability, and guaranteed performance requirements
- Enhanced perception for improved performance and process control
- Dynamic task planning
- Implementation of digital twins

Multi-robot and robot-infrastructure cooperation

- Task planning with functional redundancies
- Dynamic calibration in extended workspaces
- Modular hardware and software architectures
- Communication and control strategies

Coordination of TS3

- Identify labs and at least one contact point per lab
  - Through a survey/questionnaire sent via the GdR mailing list by the end of 2024
  - You can also register by sending an email to: ts3@gdr-robotique.org
- 2025 Actions:
  - Two scientific days focused on the two TS sub-themes:
    - Reliability and Safety
    - Multi-Robot and Robot-Infrastructure Cooperation
  - If you have any proposals or ideas, we are open to suggestions!

Talk TS3: Deployment of closely cooperating aerial robots in demanding real-world environment

Prof. Martin Saska

Czech Technical University in Prague

Heads of: Multi-robot Systems lab, and Center for Robotics and Autonomous Systems

Winner of multiple robotic challenges in MBZIRC 2017, MBZIRC 2020 and DARPA SubT competitions

Author of >150 publications conferences and >80 publications in impacted journals

Keywords: Multi-robot Systems, Autonomous Aerial Vehicles, Swarming and Cooperation, Real-world Applications