A ROS based architecture for an autonomous chemistry laboratory

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What is this talk about?

“Developing a self-driving autonomous scientific laboratory powered by artificial intelligence and robotics.”

Cooperative, heterogeneous and adaptive robots for an autonomous chemistry laboratory: recent advances and open challenges towards the scientific lab of the future
Motivation:
Scientists at work in laboratory

https://youtu.be/X-HyiirHulo
Motivation: Robotic Scientist

• Autonomous mobile robot scientist

• Dexterous - can work with equipment / scales that are relevant to scientific labs

Source: Andrew I. Cooper - Autonomous Materials Discovery / University of Liverpool
Robotic Scientist

Autonomous mobile robot - Autonomous discovery

Source: Andrew I. Cooper - Autonomous Materials Discovery / University of Liverpool
Self-driving Autonomous Lab: Communication “Middleware”

**Robot Operating System (ROS)**

Goal:
abstract away interprocess communication (IPC) and cross-network communication details
Challenge: perception

OpenCV

2D camera

Vial

https://youtu.be/rdPkkdZ7IeE

https://youtu.be/4HAKkNNp9FE
Self-driving Autonomous Lab: challenges

Challenge: Perception and control (Visual servoing)
OpenCV + Movelt!

https://youtu.be/iwKtckYdE2M
Self-driving Autonomous Lab: challenges

Challenge: Robust autonomous navigation -> Navigation stack

Need for adaptive and *intelligent navigation*
Robot Architecture

Dynamically reconfigurable workflows – Modular and Flexible systems

• Simplification of the integration and networking of the control and sensor data utilizing web based, and ontology services

• Use of common integration architecture to monitor the execution of the task and dynamically redistribute the workflow

• Using the status reporting of the autonomous robots, the system will be able to generate alternative allocations for robots (and humans).
Dynamically reconfigurable workflows – Modular and Flexible systems - Modular architecture
Robot Architecture: Use Case: sample preparation

Dynamically reconfigurable workflows

Modular and Flexible systems
Robot Architecture:
Lab automation/interfacing

**Solid Dispensing:**
- Watson Marlow - 323DU Pump
- Dosing_status
- Door_position
- Sampler_position
- Dosing_target

**Liquid Dispensing:**
- QS30 Autosampler from Mettler-Toledo
- Pump_status
- Pump_speed
- Pump_direction
- Timer

**Mixing:**
- IKA ULTRA - TURRAX
- mixer_status
- Speed_target
- Timer

**RS232 - Serial Interface**
Heterogenous and collaborative robots
Collaborative task: vial capper/decapper and transfer

Robot Architecture

Dynamically reconfigurable workflows
Modular and Flexible systems

ROS

https://youtu.be/tgWzPMPSeOM
Autonomous and Intelligent Labs:
Future Vision

Future vision
Computational Brain
Robotic Research Agents
Thank you

Let's Make Robots!!!

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