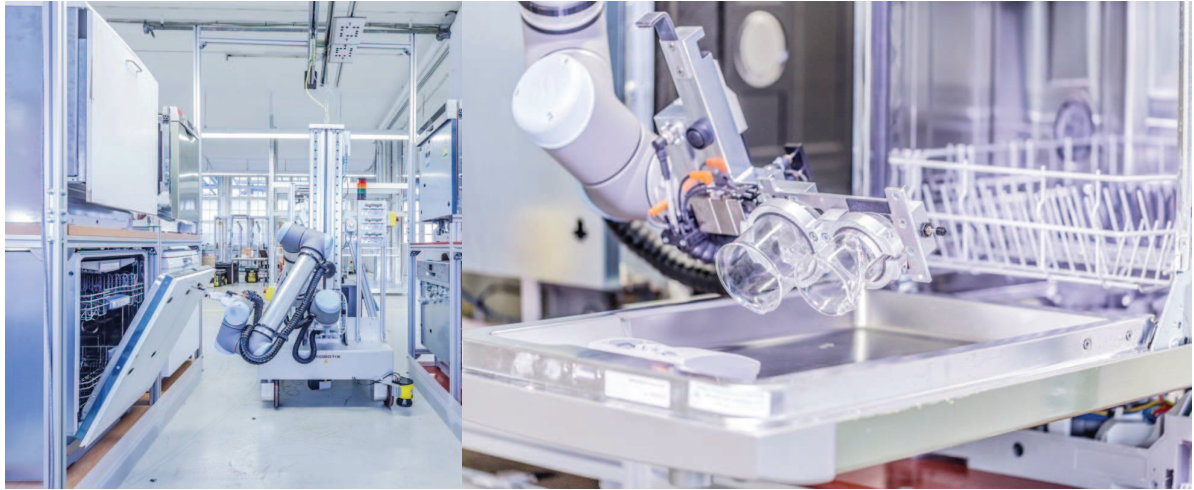


Robotics for lifetime tests of dishwashers

ROBOTICS FOR LIFETIME TESTS OF DISHWASHERS

Joshua Hampp



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IPA

Use Case: Tests of dishwashers

- Dishwasher
 - Tool of daily domestic work
 - Reliable home help

→Quality Management assures functioning

- Manufacturers run extensive tests:
 - Lifetime and endurance tests
 - Under different conditions
- Test case to automate in this project with BSH:
 - Testing of the whole dishwasher
 - Simulation of normal use



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Use Case: Tests of dishwashers

- Test procedure:
 1. Pour in dirt
 2. Insert cleaning tablets
 3. Using dish rack
 4. Starting the dishwasher



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Use Case: Tests of dishwashers

- Environment:
 - One or more lanes with dishwashers
 - Over 40 dishwashers in each lane
 - Central loading facility for dirt and cleaning tablets



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Use Case: Tests of dishwashers

- Requirements of the robot:
 - Mobile platform
 - Manipulator with adapted gripper
 - Depot for
 - Cleaning Tablets
 - Dirt
 - User Interface (UI)
 - Simple (non-programmers)
 - Supporting safety
 - Communication with
 - Dishwashers
 - Loading facility
 - CE mark (safety)



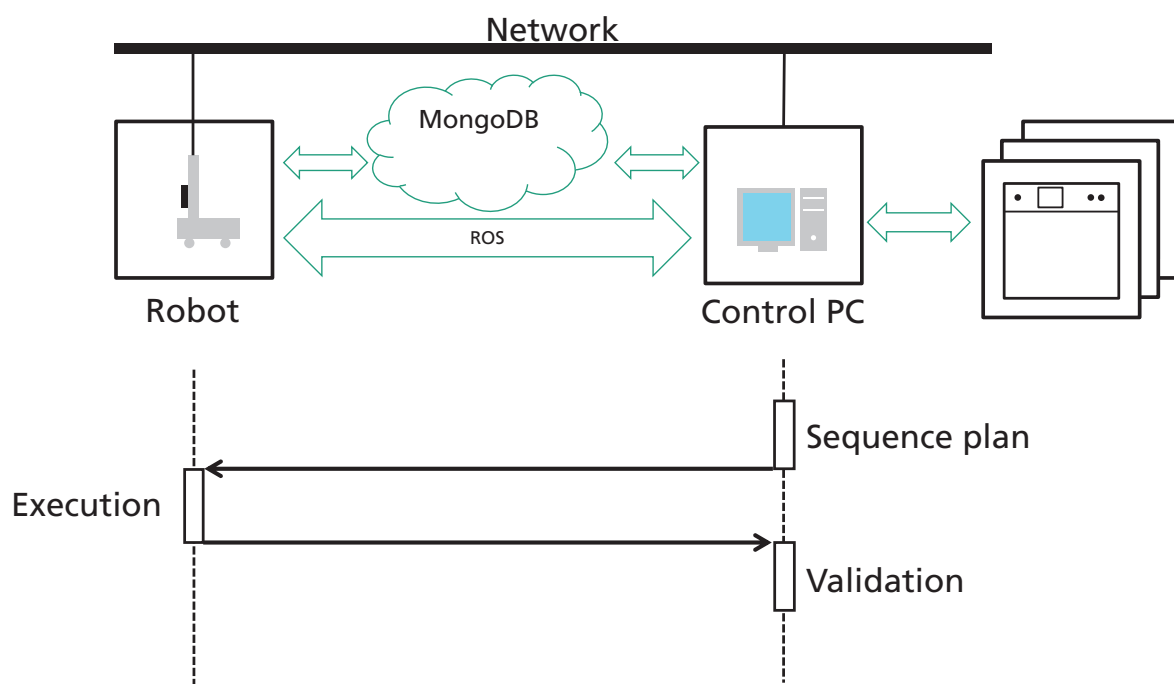
Technical implementation of the use case

- Hardware
 - Conductor rail
 - Omni-directional drives
 - Universal Robots arm
 - Lift axis
 - 2 Laser Scanners
 - Signals
 - Cleaning tablets depot
 - Computer & safety controller (PLC)
 - Camera system



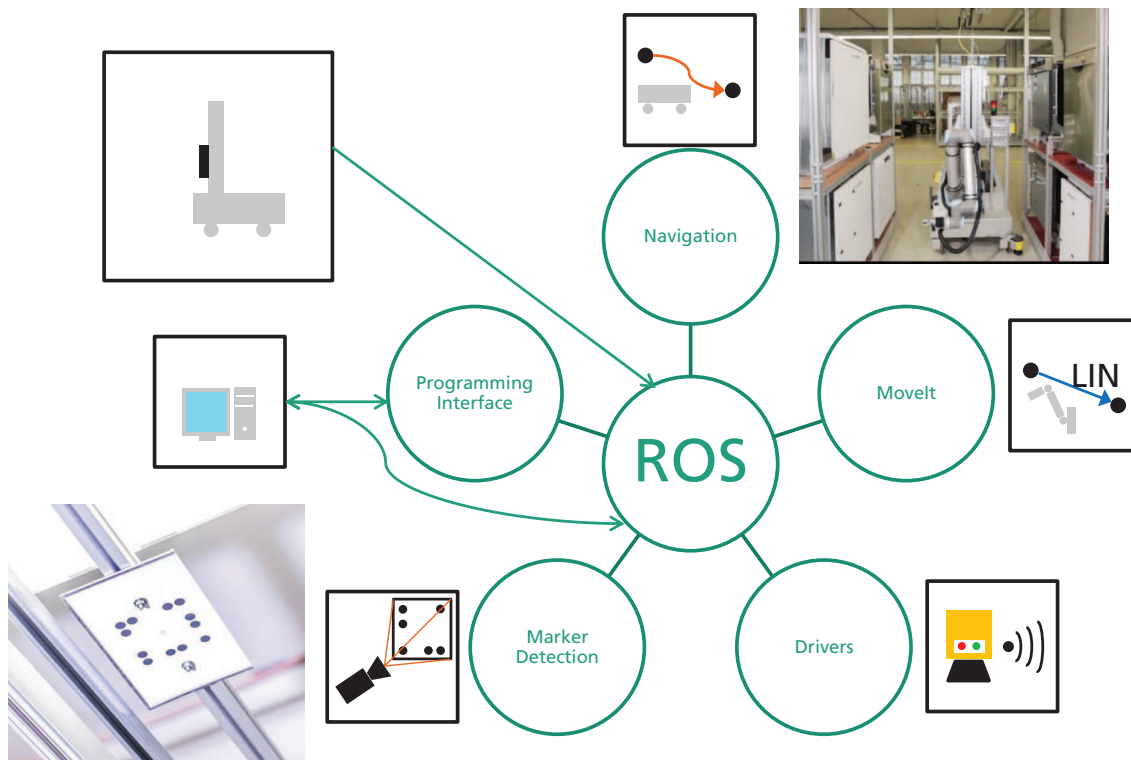
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Technical implementation of the use case



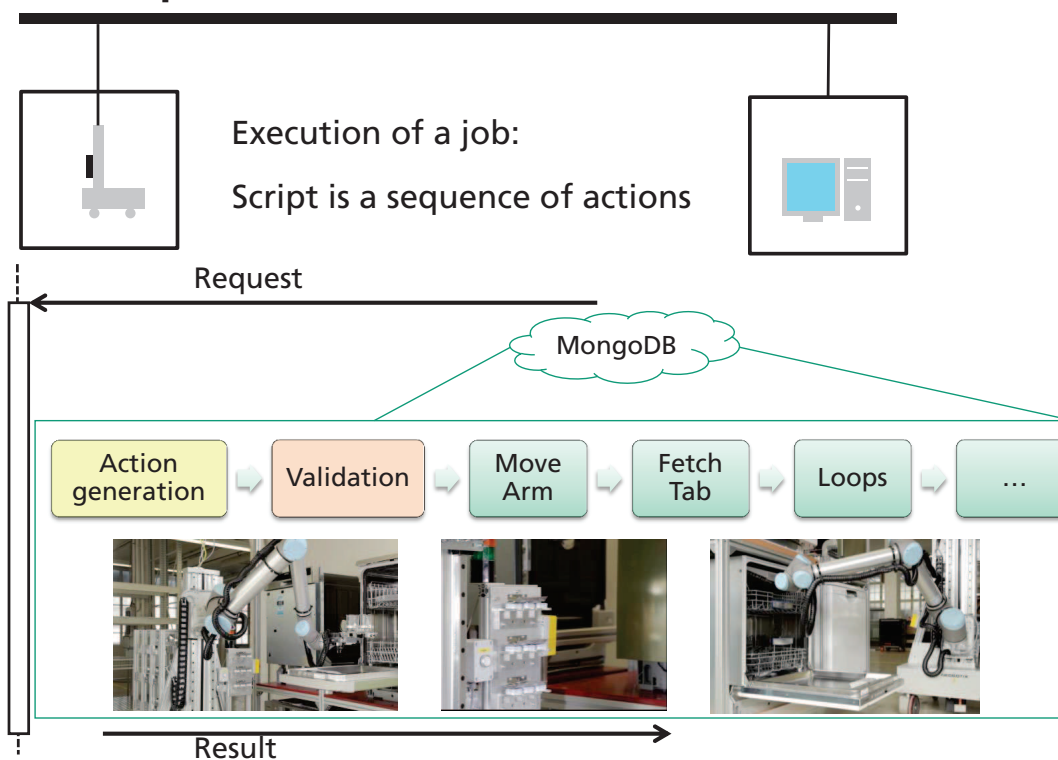
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Technical implementation of the use case



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Technical implementation of the use case



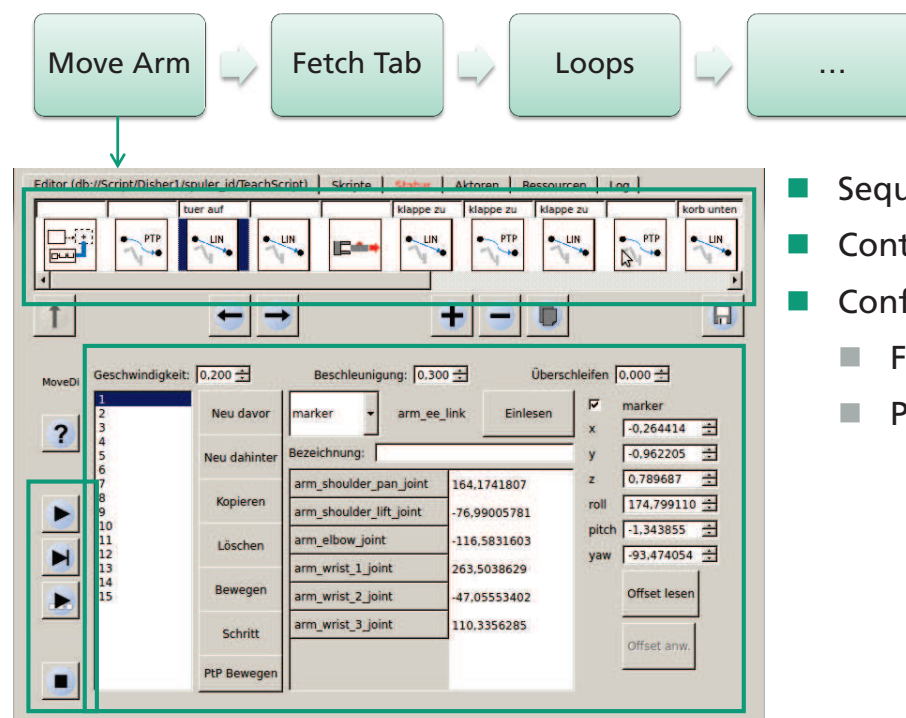
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User interface for teach-in

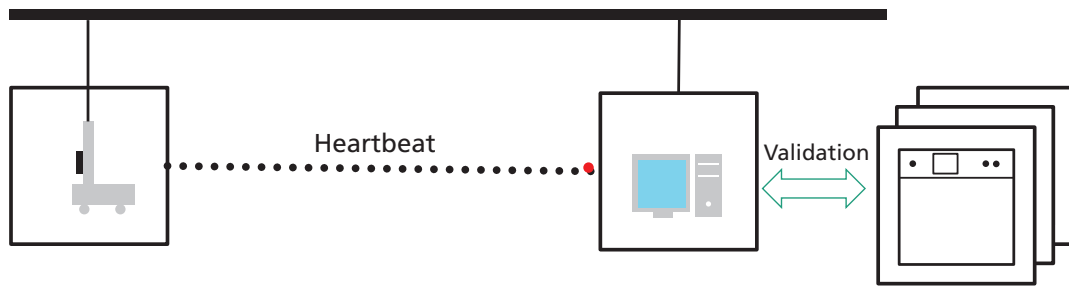
- User Interface for teach-in
 - Integrated in UI of Universal Robots
 - Only in "teach mode" available
 - Control of the complete robot
 - Editing of scripts
 - Information about the robot
- Teach button at the gripper
 - Hand-guided manipulator
 - Two-channel switch



User interface for teach-in



Soft safety features (ROS and UI)



- Heartbeat ensures control PC is alive
- State of dishwashers are validated after each execution
- Collision checks
 - 3D environment model of ground, ceiling and lane
 - Check before movement of arm or lift
- Validation of gripper state
- Each script is checked for validity (collisions, robot state)

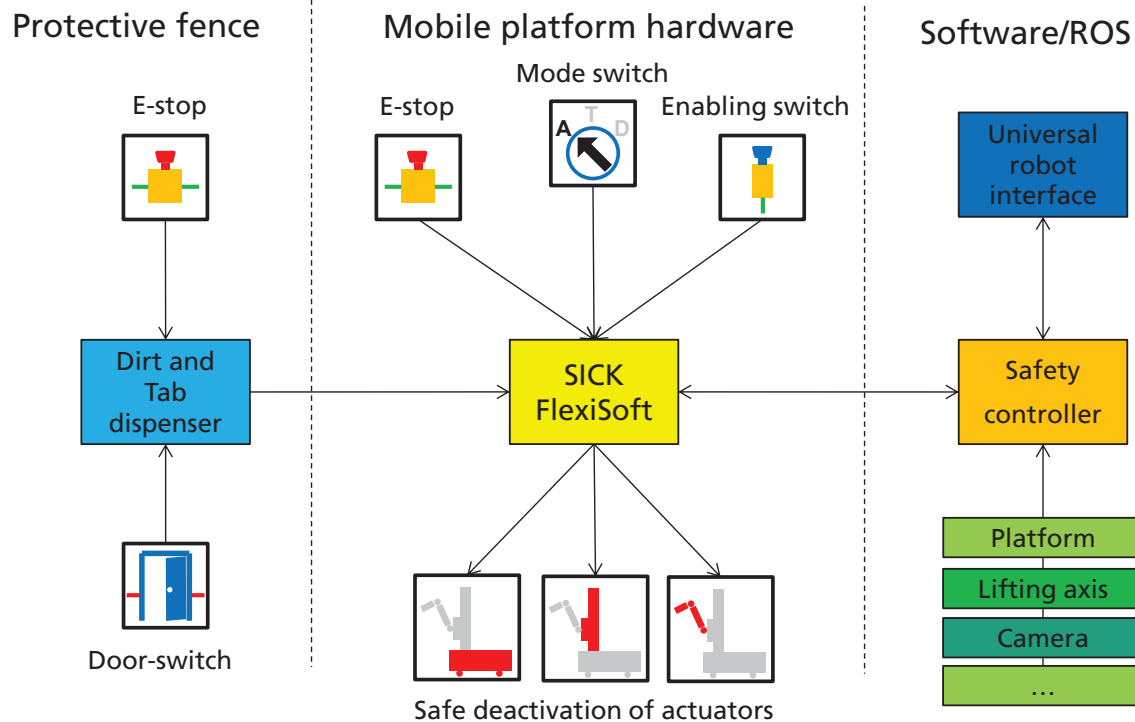
Hard safety features

- Hazard identification and risk reduction was performed in order to apply a CE mark
 - Automatic mode (all components activated)
 - Requires separation of human and robot by a fence
 - For teaching, human has to enter the fenced area to interact with the robot
 - Drive mode (base activated)
 - Teach mode (lift axis and manipulator activated)
- Safety measures depending on risk level
- Size of protective fields determined according to ISO 13855
 - Different resetting behavior
- Safety functions with performance level d or more



Note: ROS is potential "unsafe"

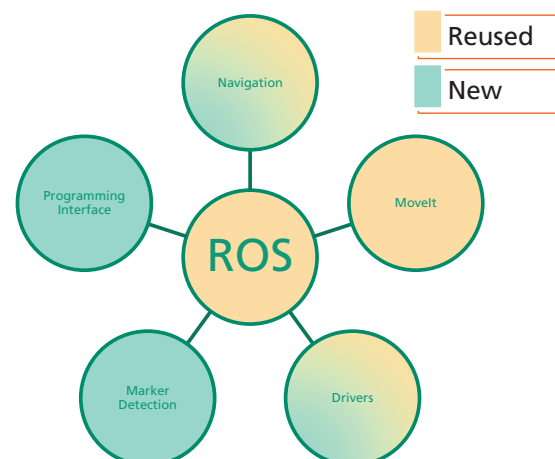
Hard safety features: System architecture



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Experiences with ROS (reusability and extendibility)

- Benefits of ROS for this project
 - Standardized communication model
 - Reuse of many components
 - Ease of extensions
 - Debugging tools
 - Latest technologies
- Challenges
 - Stable driver development
 - Safety certification



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ROS-INDUSTRIAL

TECHNOLOGIES, TRENDS, APPLICATIONS