TAČR: Advanced Robotic Architectures for Industrial Inspection (ADRA-2I)

Project number: TF02000041

Multi-redundant NDT robot

([Gprot] Multi-redundantní robot pro nedestruktivní průmyslovou inspekci)

(Czech pilot)

D14. (UJV) Multi-redundant NDT inspection robot (demonstrator)

(Hardware)

Martin Švejda, Arnold Jáger, Lukáš Bláha, Tomáš Čechura, Vlastimil Šetka, David Tolar (ZCU), Petr Barták (SM)

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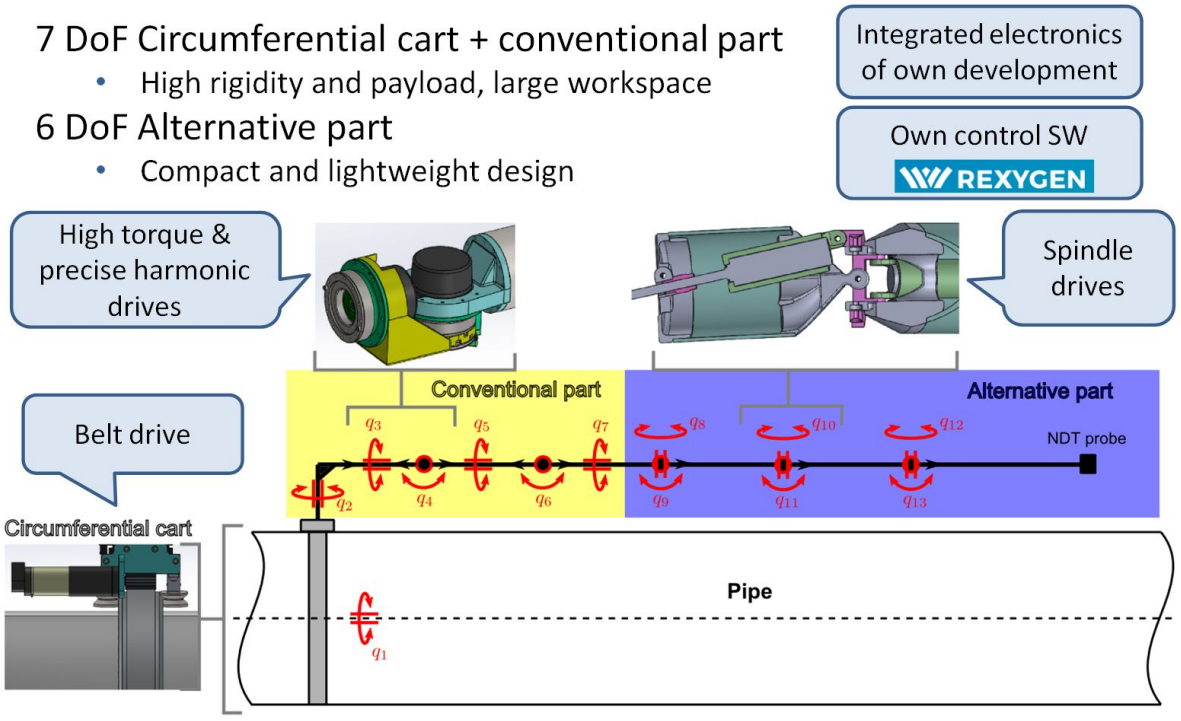
Company ID:
UWB - University of West Bohemia, SM - SmartMotion s.r.o., UJV - UJV Rez, a. s

Description:

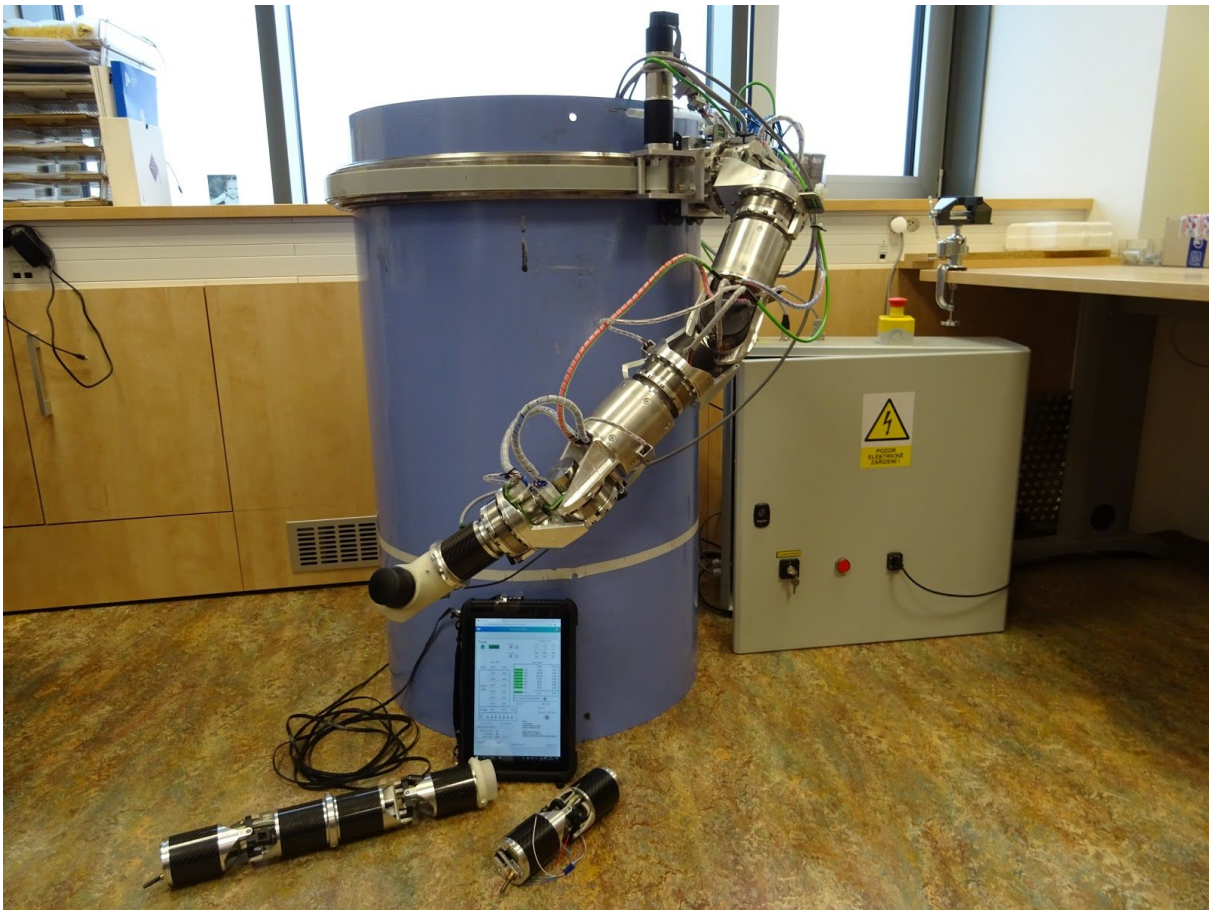
The prototype of the multi-redundant robot ROBIN (ROBotic INspection) was developed and corresponds to the key demands on Non Destructive Testing (NDT) applications. The prototype of the robot brings the first proof-of-concept of robotic technology which is suitable for dealing with complex-shaped trajectories of NDT probe and it is able to operate in the high-restricted areas. The manipulator has been developed as a hyper-redundant robot, divided into three main parts, namely as: *Circumferential carriage module, Conventional part of hyper-redundant module, Alternative part of hyper-redundant module*. Each part of manipulator has been developed according to inspection demands and restrictions.



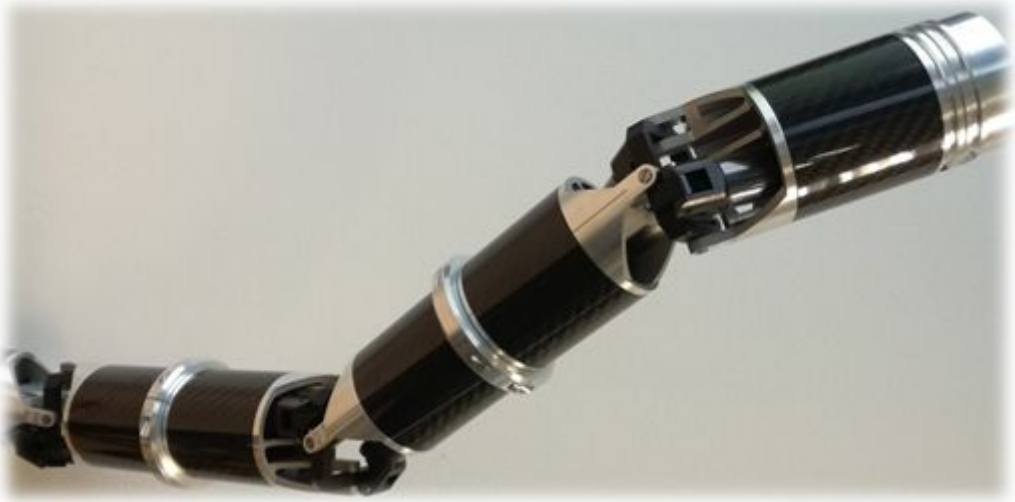
Layout of Robot Design

Key features:

- Designed for operations on pipelines with very confined space
- Modular concept for different NDT tasks
- Intuitive representation of motion (JOG) in pipeline Developed view, where common obstacles are defined according input pipeline documentation
- Useful for systematic monitoring and repeatability
- Elimination of manual inaccuracies



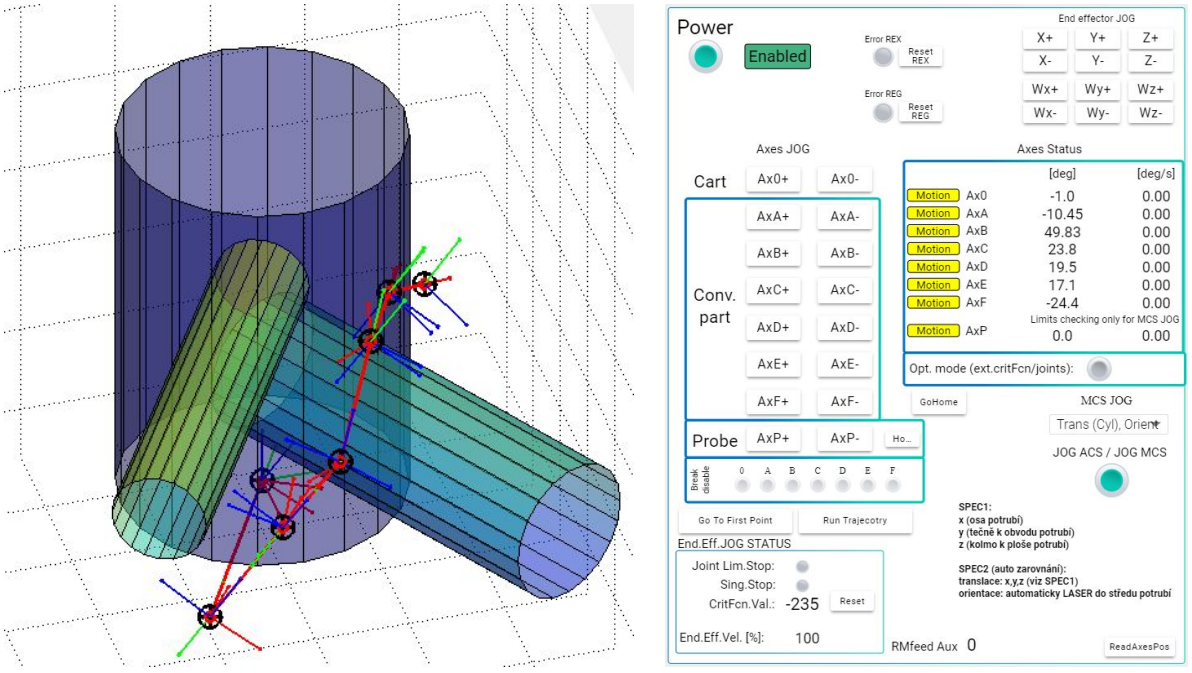
Final prototype of robot Conventional part



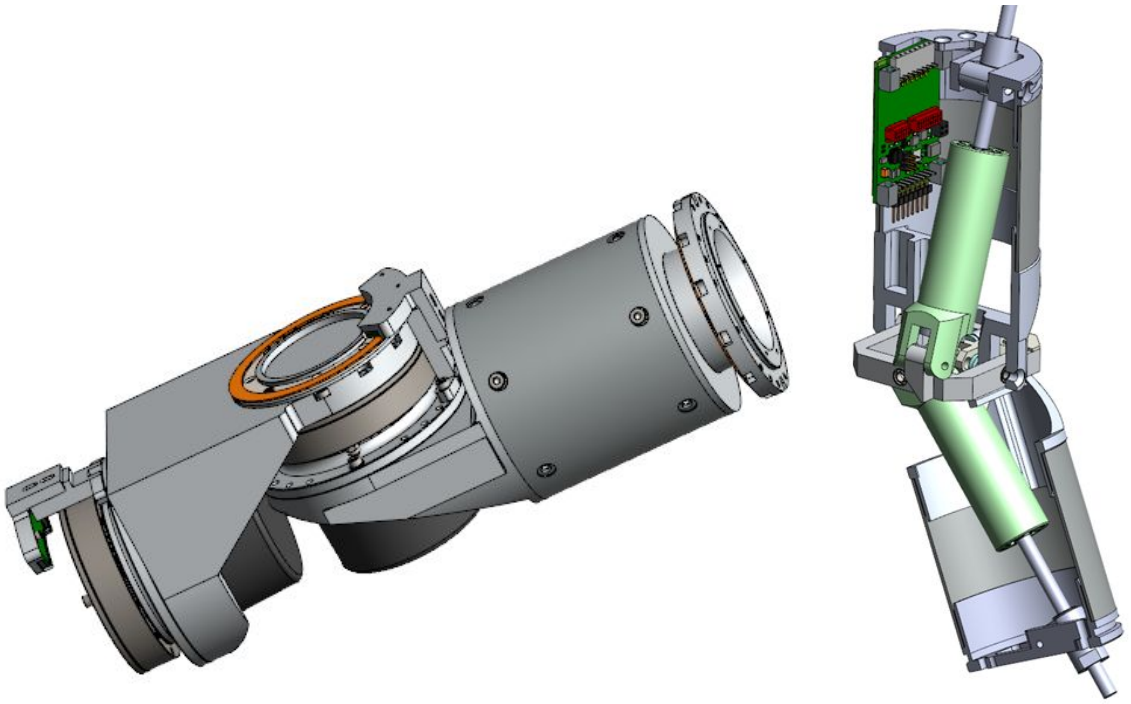
Detailed view of robot Alternative part

Realization of the prototype:

- **Virtual simulation model of the robot** was implemented in Matlab / Simulink / SimMechanics
- **Control system software of the robot** was implemented in REXYGEN real-time control system (including advanced motion control algorithms)
- **WEB HMI/visualization** was implemented in Inkscape Free SW (natively integrated into REXYGEN HMI Designer)
- **Mechanical construction of the manipulator** was created in the form of 3D CAD layouts which serve as a background for manufacturing (manufactured robot components see above)
- **Electrical components of the robot parts** was realized as follows:
    - *Control units of alternative part of the robot:* Electronics of own development AMC2 (Advanced Motion Controller the 2nd generation)
    - *Control units of alternative part:* Faulhaber Motion Controller MCDC 3002 P + CAN/EtherCAT converter of our own development
    - *Hand-guidance Space Mouse Joystick:* MEGATRON SpaceMouse® Module
    - *Model of the NDT probe:* 3D printed NDT transducer and wedge with respect to given NDT procedure (declared by the UJV specialist)
- **Robot controller** was realized as electric switchboard, consists of:
    - Industrial PC (B&R Automation PC 3100)
    - Power management subsystem
    - I/O subsystem (B&R remote I/O via EtherCAT)
    - Safety subsystem (safety relay circuit)
- **Operator panel** was realized as thin-client (supported by the REXYGEN HMI standard) with industrial tablet as target HW platform

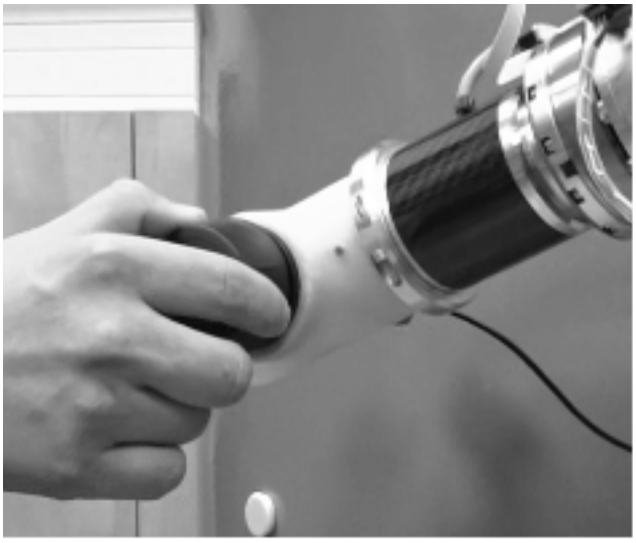


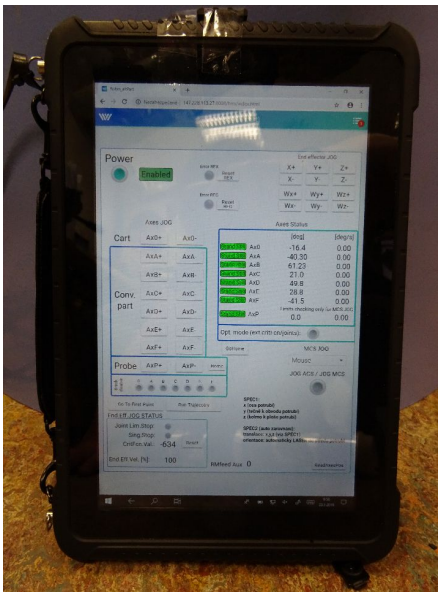
Virtual simulation model (left), WEB HMI visualization (right)



CAD layout of the robot joints: Conventional part (left), Alternative part (right)

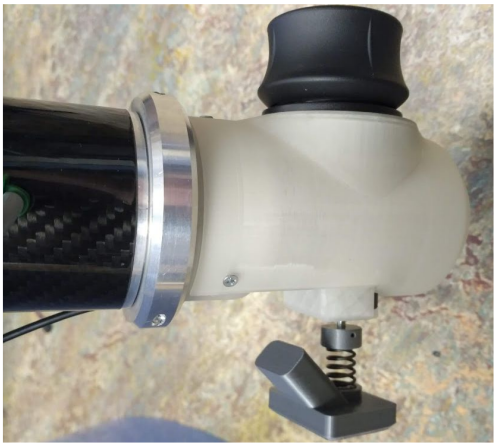
AMC2 controller (left), Faulhaber controller + extended communication board (right)





Hand guidance of the robot end-effector (left) and operator panel (right)

Implementation of Electric switchboard



Model of the NDT probe including flexible housing

Contact / availability:

For more information please follow the references:

1. D16. Robotic prototypes documentation, [O] Dokumentace prototypů (výsledek č. TF02000041-V4)
2. Promo materials: https://drive.google.com/drive/folders/1eO87Mt2gaR0uDu_UEs12Ukr6dYmB00kb?usp=sharing

The results are available at:
University of West Bohemia,
NTIS/Department of Cybernetics
Univerzitni 8, 306 14 Pilsen, Czech Republic

Or can be obtained on request from ntis@ntis.zcu.cz

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