

User-centric solutions for a flexible and modular
manufacturing in small and medium-sized shipyard



High-payload robots in shared space with humans

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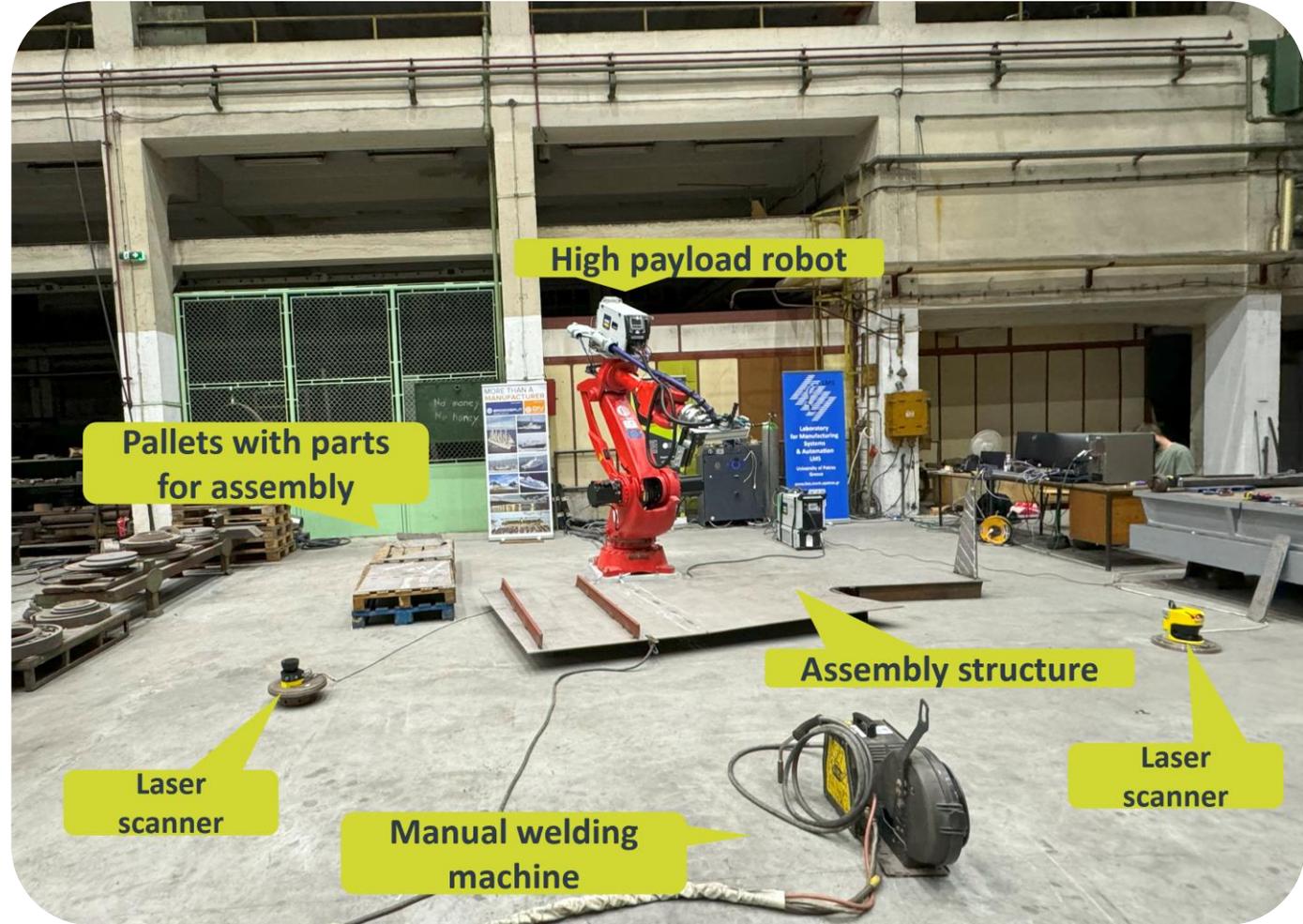
This project has received funding from the European
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High-payload robots in shared space with humans

The technology



High Payload Robot Testbench in BIS premises

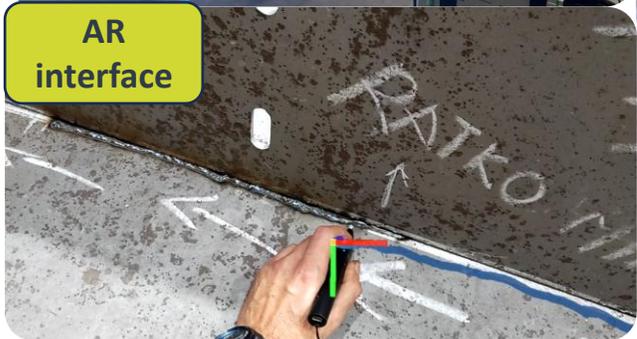
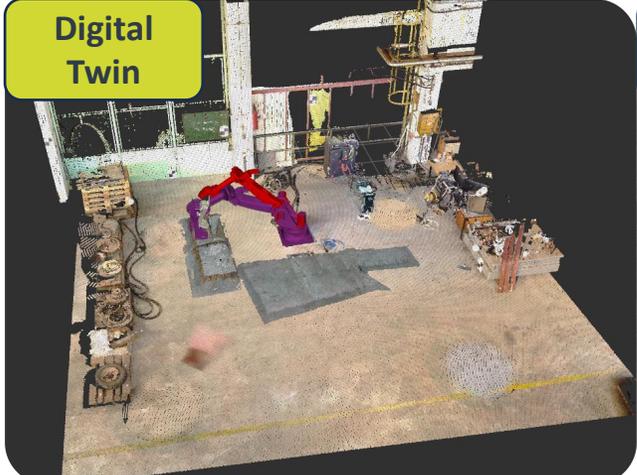
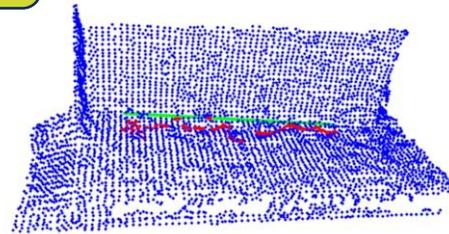
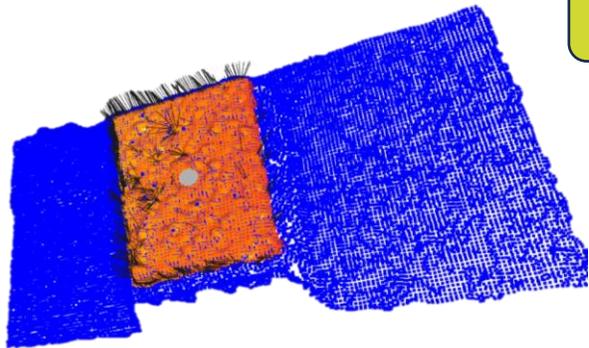


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Key Technologies in the High Payload case

- Digital Twin
- Perception systems for part and seam detection
- Workspace monitoring
- Autonomous robot welding
- Seamless AR robot programming interface
- Manual Guidance

Perception systems



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Key Technologies in the High Payload case

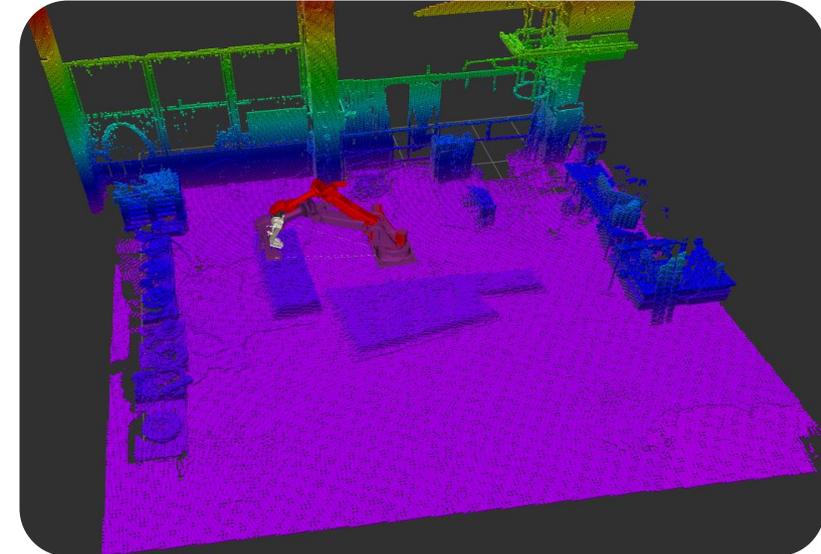
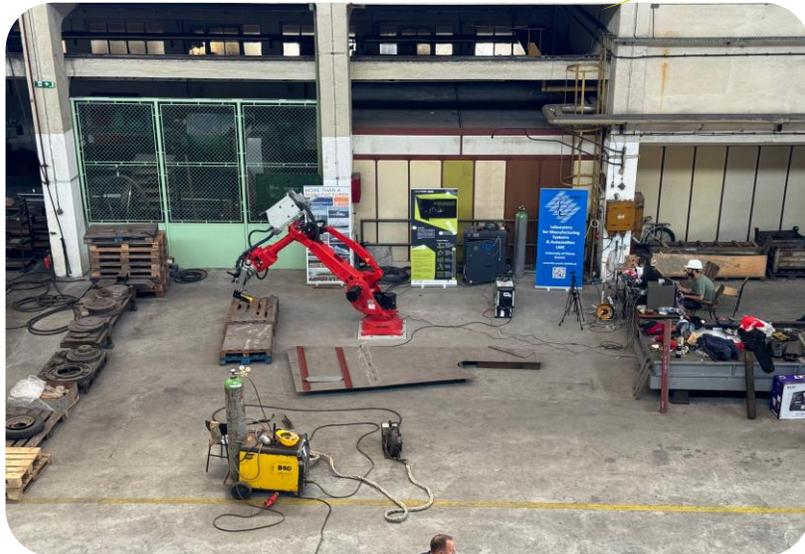
Digital Twin

- CAD-Free approach facilitates
- inaccuracies from thermal deformations
- self-deformations from parts weights etc.
- Reconfigurability and adaptation

Physical Cell

Digital Twin

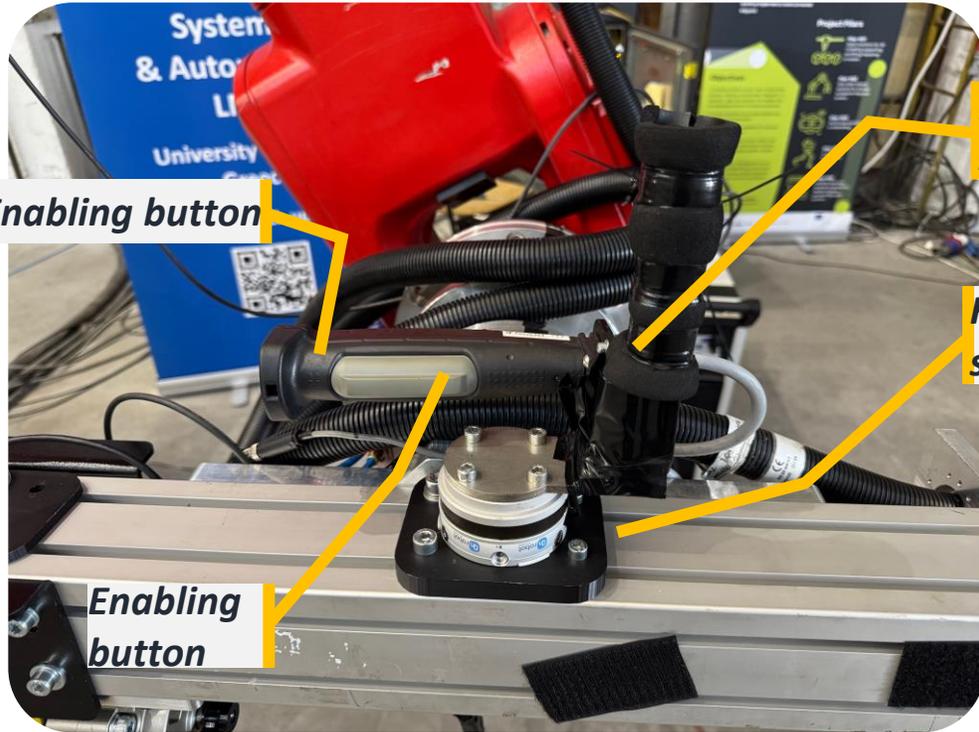
Digital Twin
Octomap
representation



Key Technologies in the High Payload case

Manual Guidance

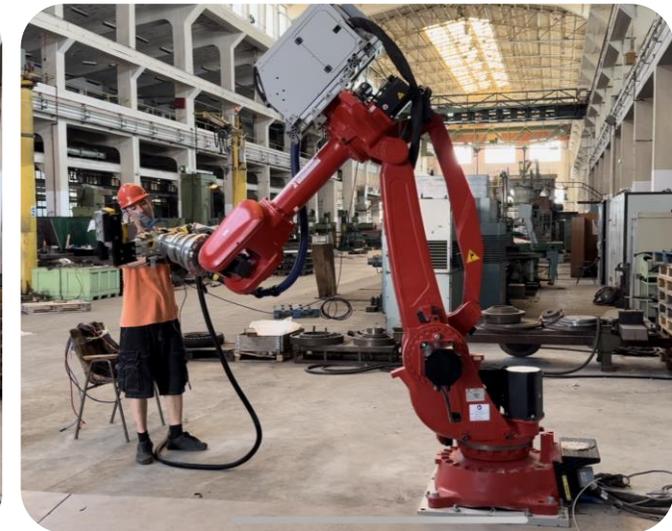
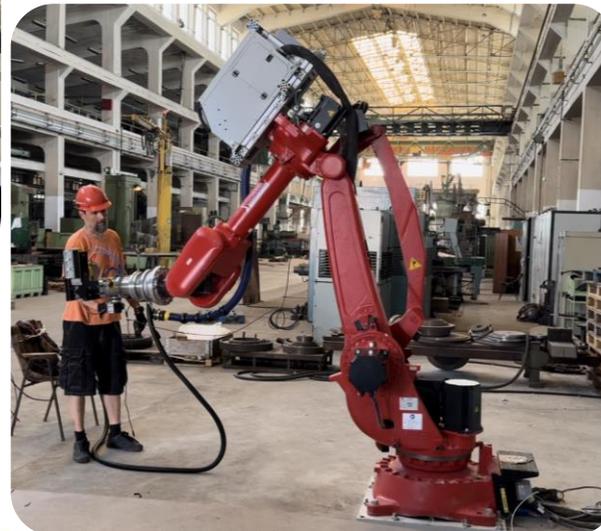
- Force/Torque based control of robot' Operator manipulates robot's end-effector in the desired pose



Hand guiding handle

Hand guiding sensor

Enabling button

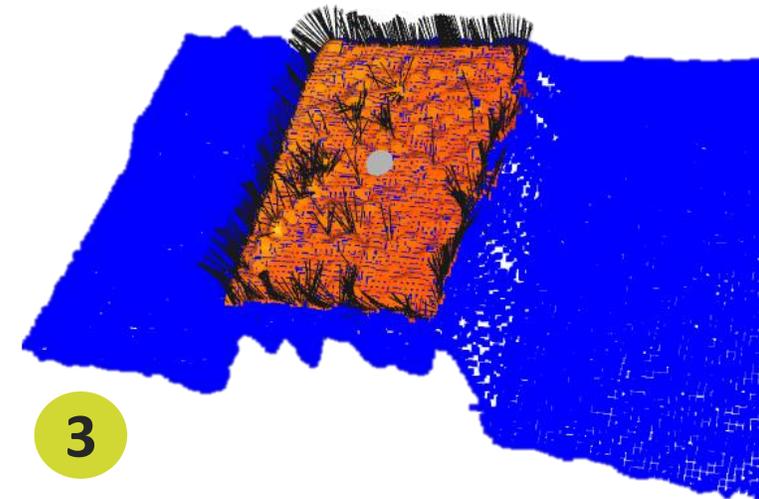
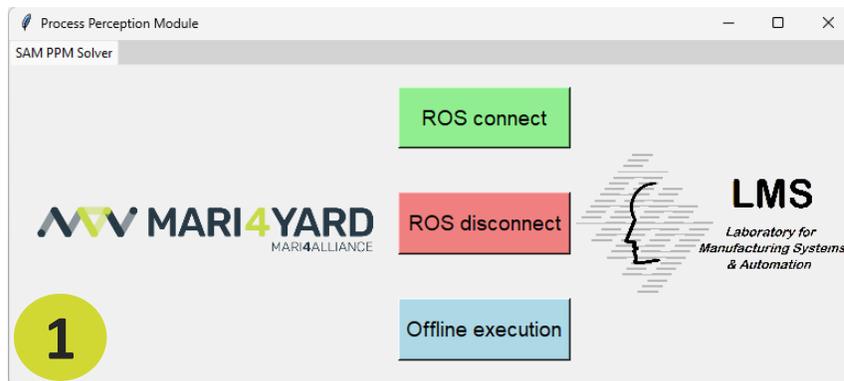


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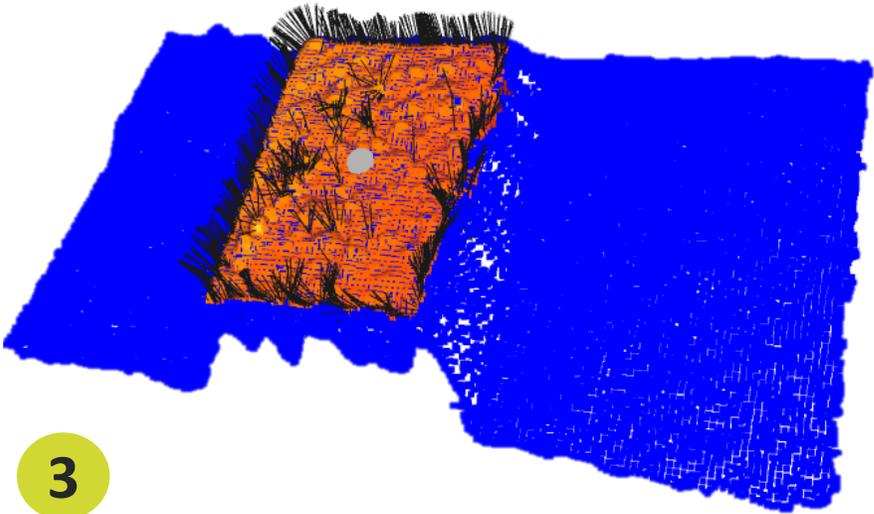
Key Technologies in the High Payload case

Process perception module for bin picking operations

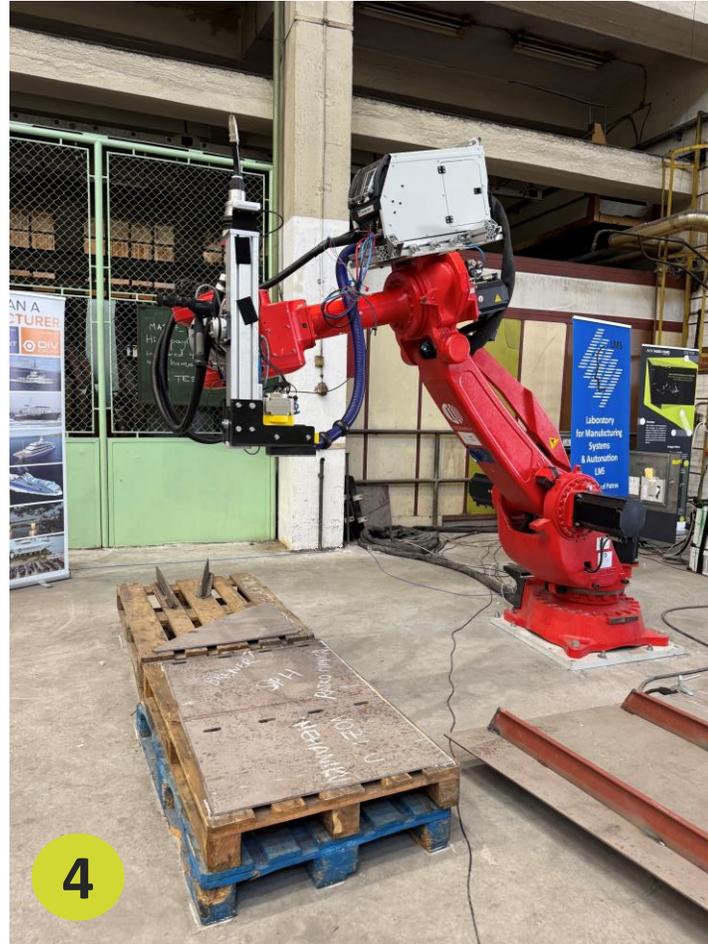
- **CAD independent** part detection
- Center of gravity (CoG) identification
- **Grasping point identification** to command the robot grasp the part



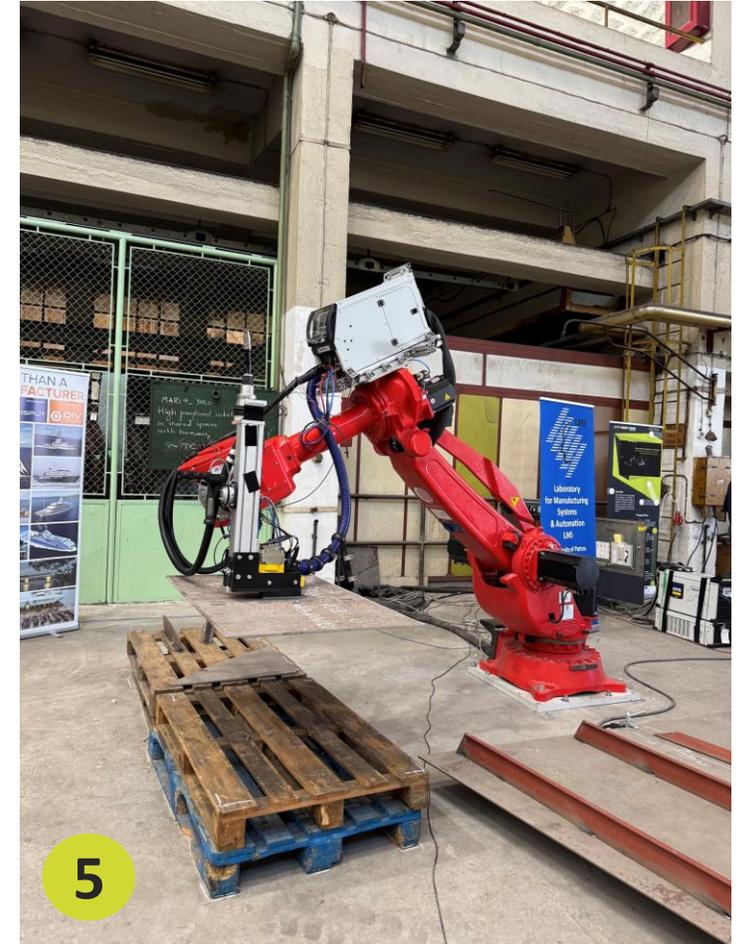
Key Technologies in the High Payload case



3



4



5

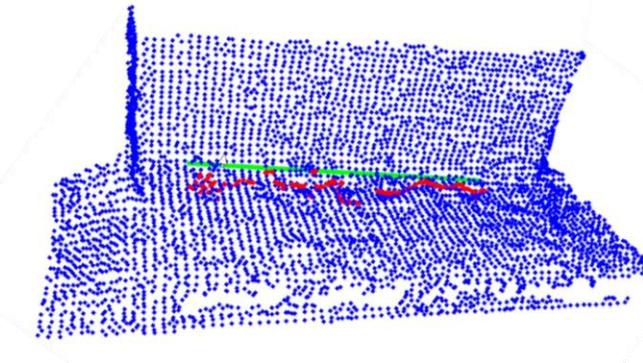
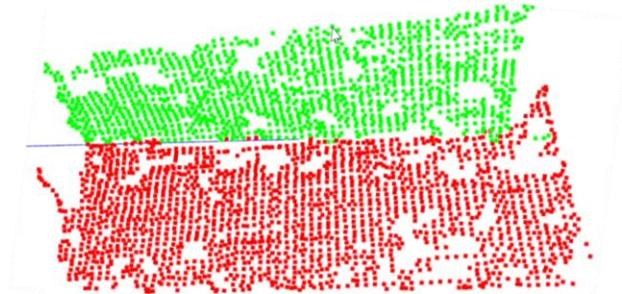


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Key Technologies in the High Payload case

AR Robot Programming interface and perception system for seam detection

- Smart Pen and AR glasses for robot path/pose teaching
- No-expert programmers
- Perception systems for the correction of the trajectory



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High-payload robots in shared space with humans

The demonstration in the shipyard



High-payload robots in shared space with humans

Scenario Description

- The robot uses a **machine vision** system to **detect parts** to be picked
- The robot **picks** and manipulates the heavy sheets and **roughly positions** them in place
- The **operator** guides the robot to the **final position**
- The operator **tack welds** the sheet to free up the robot
- The operator **teaches** the **welding seam** using the smart pen
- A **perception system** detects the **welding seam** and **corrects the robot's trajectory**
- The **robot fully welds** the sheet in place



Watch the video of [High-payload robots in shared space with humans](#)



High-payload robots in shared space with humans

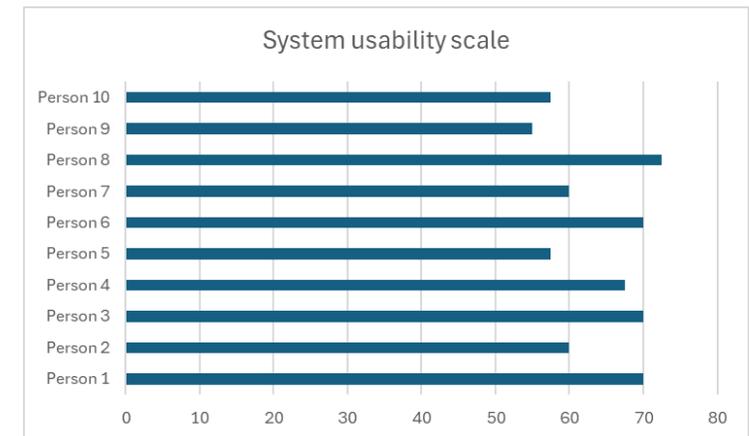
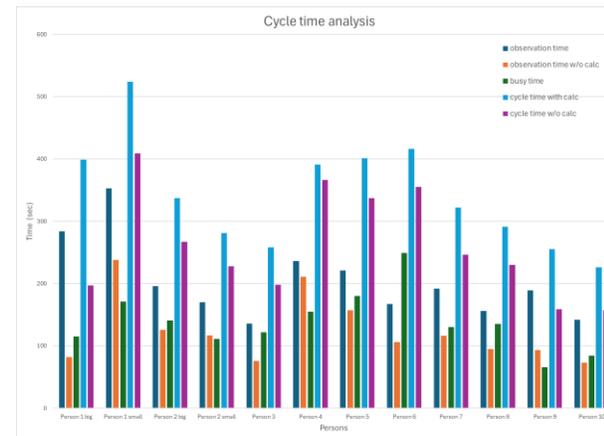
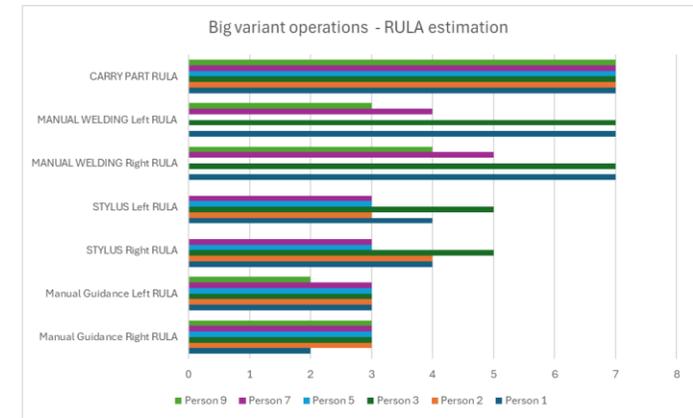
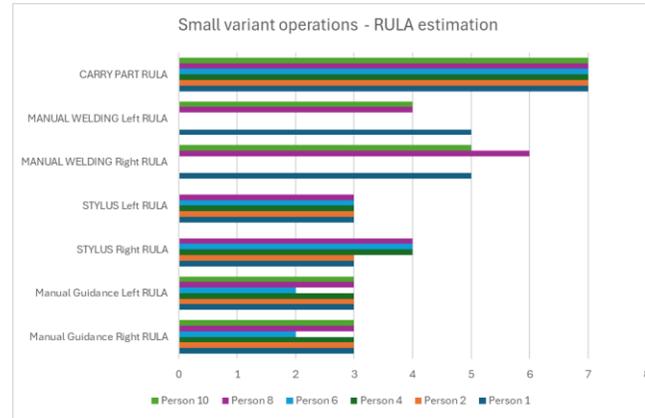
The impact for the shipbuilding industry



The impact for the shipbuilding industry

Results

- The **average cycle time** for all variants are approximately at **5:51 (4:22 without the calculation times)**
- The average RULA for the solution are:
 - **Manual Guidance: 3**
 - **Robot teaching: 4**
- The **mean system usability score** is : **64**



The impact for the shipbuilding industry

- **Reduction of operator busy time** by $\approx 67\%$ (**7:00** without HRC - **2:18** with HRC)
- **Reduction of robot programming time for welding paths** by $\approx 90\%$ (≈ 7 min by an **expert** in robotics to **40 secs** by a **non-expert**)
- **Reduction of 4 RULA points** in the **manipulation** and **positioning** of the parts (**3** for the **Manual Guidance** - **7** for the **operator manual carried** the part)

Thank you!



Catalogue
of technologies



MARI4YARD

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