RIMA project proposal
Description of the industrial case

Yann KERNIN
Nano-Innov
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Framatome at a glance

For 60 years, Framatome's teams have been involved in developing safe and competitive nuclear power worldwide by:

• designing nuclear power plants,
• supplying nuclear steam supply systems,
• designing and manufacturing components and fuel assemblies,
• integrating automation systems,
• and servicing all types of nuclear reactors.

➢ Original Equipment Manufacturer of 92 nuclear power plants
➢ 14,000 employees serving more than 250 reactors worldwide and
➢ generating a turnover of € 3.3 billion in 2018
Our worldwide presence

14,000 employees working on more than 250 reactors worldwide at 53 locations in 20 countries
Framatome shareholder structure

- Stock-listed company
- Majority shareholder: French state

100%

Framatome Inc.
Framatome GmbH
Other subsidiaries

Framatome Inc. subsidiaries
Framatome GmbH subsidiaries

75,5%

EDF

19,5%

Framatome GmbH subsidiaries

5%

Mitsubishi Heavy Industries, LTD

assystem
Our activities in a nutshell

**Engineering & Design Authority:** Development, design and licensing of Nuclear Steam Supply System (NSSS) and associated services

**Component Manufacturing:** design and manufacturing of heavy and mobile components for nuclear islands

**Instrumentation & Control (I&C):** Design and fabrication of safety I&C and automation systems for nuclear power plants

**Fuel:** development, design, licensing and fabrication of fuel assemblies and core components for PWR, BWR reactors, and research reactors. Development of zirconium products

**Installed Base:** Maintenance, engineering services for existing nuclear fleets and reactors under construction

**Large Projects:** Management and contribution to nuclear reactor new ‘build projects**
Objective as end-user

RIMA Challenge 3: Inspect/Repair of NPP equipment

- Welding
  - Adaptive feedback robotic gas tungsten arc welding (TIG)
  - Bead placement with proper orientation in weld groove and subsequent adaptation to as-welded shape
- Non Destructive Testing
  - Weld inspection in power plants
  - Ultrasonic inspection to cover the full volume of the weld
  - Ultrasonic beam need to be oriented correctly according to the surface geometry and the expected defects

The component shape is complex, the exact geometry is not known and the positioning accuracy of the welding tool or the ultrasonic probe is important.

Place and move a « tool » automatically and relatively to the real geometry of the component with a multi-axis robot.
Actual status

- On site laser scan of the component
- Point cloud management to generate a CAD file of the component
- Robot programming taking in account component geometry, welding or ultrasonic inspection requirements
- On-site robot installation and adjustment
- Alignment correction (hardware and software) between the robot and the component to get the best trajectory
- Welding or ultrasonic inspection operations

Generate excessive operations duration and operator dosimetry
Description of operations

Welding
- TIG welding head (tungsten, wire feed, shielding gas)
  - Automatic voltage control to manage stand-off distance
- Adapt to standard, commercially available robots that are easy to transport to the workpiece
- Scan of environment to identify interferences
- Scan of weld / repair area and define bead placement
- Weld a single pass and scan as-welded configuration

Non Destructive Testing
- Use of a flexible ultrasonic array probe
- Use of a commercial robot
- Trajectory in daisy “shape”
- Ultrasonic probe distance and angle to the component could be measured by processing the ultrasonic signal