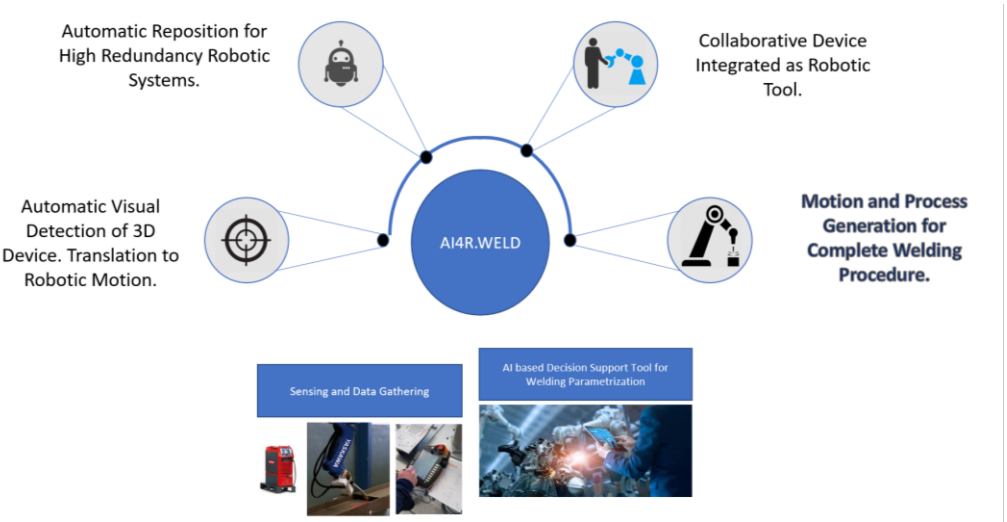
AI4R.WELD

AI for Robotic Welding Parametrisation and Inspection - AI4R.WELD

By Pedro Tavares, SARKKIS Robotics, Lda.

Project Details and Motivation

Robotised Welding is one of the most demanding technological processes to tune due to the numerous variables that are in play, such as the materials to be welded, the wire, gases, external conditions, welding technologies, torch paths/techniques among many others. Manual welding operations are enabled by the best sensor/learning combo available (the human's senses and cognitive capabilities). Notwithstanding this current robotic welding parametrisation is achieved through "educated guess"-based decision making based on operator expertise, which results in waste during trials and due to product quality problems. Considering mass customisation fabrication, flexibility is an important factor to address. The ability to reconfigure work cells for new parts and fixtures and parts requires a dynamic digitalisation framework able to cope with environment modifications. Currently, the adoption of robotic welding systems by mass customisation fabrication is still very low due to, amongst other aspects, the lack of intuitive human-machine interfaces that integrate easy programming and quality control. The AI4R.WELD consortium believes that the key to streamline robotic welding relies on the usage of smart sensing, capable of collecting extracting information, e.g., temperature, humidity, 3D shapes, position, and orientation combined with machine learning to automatically adapt robots' behaviour and specific process parametrisation according to the environment.



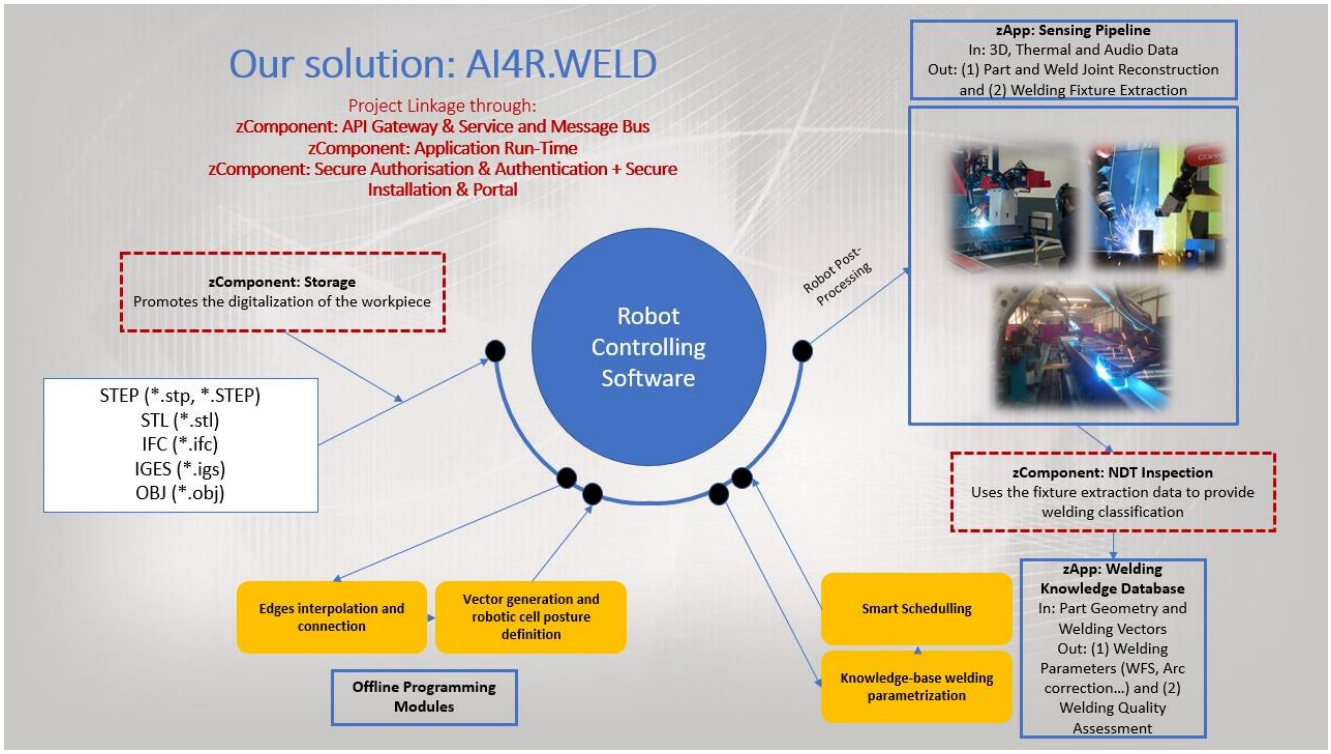
The AI4R.WELD project aims to both complement existing robotic welding technologies in the field and broaden SARKKIS's portfolio of commercial solutions, by providing a new and easy-to-use solution for zero-defect smart manufacturing. This solution is composed of a (1) Service for the correct parametrisation of welding tasks and (2) Product that promotes the usage of smart sensing for quality control for efficient robotic welding.

ZDMP Fit

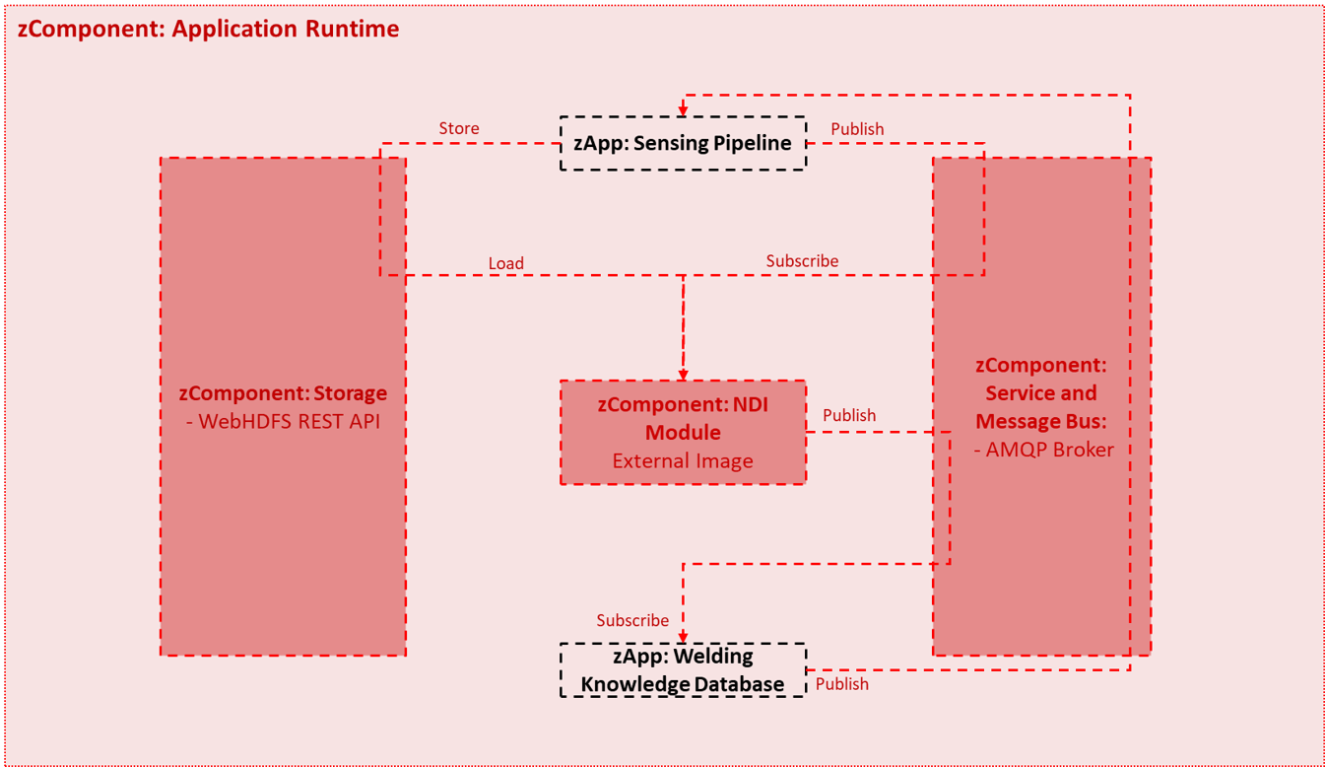
In the AI4R.Weld solution architecture, all software modules will be controlled by the commercial software MetroID PrimeWELD, providing sufficient data to generate all key parameters and operation constraints to the robot.

From this central software are integrated multiple ZDMP components. The ones that are intended to be developed are related to operation inspection and control. First the sensing pipeline feeds data from the real scenario to correct part-posture and adjust the processed plan to the real live data. Then the same pipeline recovers the final welding data and injects them in a zComponent of the NDT inspection. Then, the parametrisation module gathers the information from the visual inspection and reacts to the changes with adaptations on the welding parametrisation. Both these modules, will work separate from PrimeWELD, being called upon necessity. From the ZDMP ecosystem, the solution will use the digitalisation

module to recreate the 3D part as a digital representative, as well as the NDT inspection to gather and filter important information of the visual inspection.



Although the generic architecture is centralised, all modules are developed in a plug-n-play methodology which enables flexibility for current and future developments, following the ZDMP architecture, as proposed below.



Results to Date

AI4R.WELD has developed relevant results for the machine learning classification pipeline and sensing and estimation pipeline. Regarding the first, the goal is to build on top of a welding knowledge database using two separate stages:

- Classification through Random Forest: The classification model implemented is learnt based on user parametrisation on the OLP software and the results of sensed results from NDT inspection.
- Prediction through Monte Carlo Simulation: The algorithm generates random values for each parameter between a given range, and with these values uses the machine learning model as the cost function. Based on each classification, the values are recalculated, proportionally to the classification value (a better classification results in a bigger increase in the frequency of the values that generated it).

Then, regarding the sensing pipeline the goal was to integrate the ZDMP message exchange interface while processing a structural steel element decomposing such element into raw welding joint data. In that case the Point Cloud acquisition has been filtered and run through a RANSAC plane segmentation, followed by a quadratic error minimisation to provide the most suitable joint estimation. Then this data is stored into ZDMP Storage through an already developed ROS-Interface.

Participant Details

- **Organization:** SARKKIS Robotics Lda
  - **Webiste:** www.sarkkis.com
  - **Contact Person:** Pedro Tavares (pedro.tavares@sarkkis.com)
  - **Profile:** SARKKIS is focused on the development of advanced robotic systems. The product portfolio is related to the structural steel sector, including offline programming systems for cutting drilling and welding and, also, a flagship machine for the structural steel welding. SARKKIS aims to integrate innovative robotics solutions combining automatic robot programming and sensing.

- **Organization:** INESC TEC
  - **Website:** https://www.inesctec.pt/en
  - **Contact Person:** Luis Rocha (luis.f.rocha@inesctec.pt)
  - **Profile:** INESC TEC is an Associate Laboratory with 35 years of experience in R&D and technology transfer. INESC TEC brings closer together academia, companies, and society in a dedicated effort to scientific research and technological development, technology transfer, advanced consulting, and training.

Environment

The ZDMP – Zero Defects Manufacturing Platform – is a project funded by the H2020 Framework Programme of the European Commission under Grant Agreement 825631 and conducted from January 2019 until December 2022. It engages 31 partners (Users, Technology Providers, Consultants and Research Institutes) with a mission to “Provide the platform, components, services, and marketplace to achieve the right product, at the right time, with the right conditions using the right resources.". Further information can be found at www.zdmp.eu. ZDMP channels 3.2M€ of SME orientated funding to subprojects, such as this one to both facilitate SMEs with their innovations and increase the value of the ZDMP ecosystem.

Links

• **Primary Partner:**	pedro.tavares@sarkkis.com
• **Secondary Partner:**	luis.f.rocha@inesctec.pt
• **Sub project website/blog**	http://www.sarkkis.com/mechatronics/rd/ongoing-projects/zdmp-ai4r-weld/
• **Architecture Component/App(s)**	zComponent: API Gateway & Service and Message Bus; zComponent: Application Run-Time; zComponent: Secure Authorisation & Authentication + Secure Installation & Portal; zComponent: Digital Twin; zComponent: NDT Inspection;