AID4SME

Combined AI and Data solutions for DATA COLLECTION

Challenge 1.1

Augmented sensing solution

1 Combined AI and Data solutions for DATA COLLECTION

1.1 Augmented sensing solution

Challenge and context

Forces, stresses, torques, and power are direct indicators of a system's well being. However, these quantities are typically expensive, difficult and intrusive to measure. Digital twins approach within AID4SME can help alleviate these hurdles for use cases inside and outside the consortium. Digital twins offer a paradigm shift where computational models of various complexities are merged in a coherent framework and linked to online measurement data available on a physical system. This paradigm allows for a hyper-realistic representation of process behaviour, enabling novel engineering applications and process improvements, such as virtual or augmented sensors. Augmented sensing uses cheap, readily available, non-intrusive, and robust physical sensors to collect data from the real asset component in a digital twin. The desired, yet unknown, quantities are estimated, resulting in a real-time/online virtual sensor fed with real measurement data enriched with physical insights.

Use case and expected solution

Within the consortium, Arçelik requires an augmented sensing solution for its refrigerator production facility, which undergoes approximately 120 mold changes per month. Each change necessitates manual, iterative adjustments, causing about 60 tons/year of polyurethane waste and about 60 minutes of facility downtime per model change. This results in approximately 160K euros in annual costs due to production capacity loss. The solution will enable accurate monitoring of forces, stresses, or other relevant physical quantities during plastic mold changes in the refrigerator production line. It will provide real-time feedback and predictive insights to reduce manual intervention and iterative adjustments during mold changes, minimize polyurethane waste, and reduce facility downtime. For this industrial high TRL application, Arçelik has foreseen the following Key Performance Indicators (KPIs): (i) First time-right adjustment of the mold; (ii) Reduce facility downtime by 15%; (iii) Decrease annual waste by 3 tons; (iv) reduction in energy consumption per mold change. These KPIs are initial indicative numbers and may evolve during the execution of the projects. Besides this high-TRL application, KU Leuven has technology blocks available at TRL 4 and low-TRL playgrounds to develop and test augmented sensing solutions, specifically for mecha(tro)nic system level dynamics, and model-based augmented sensing in electro-thermo-mechanical applications in the manufacturing industry. For application on the low-TRL research lab playgrounds, the focus will be on the technological development of the augmented sensing solution with TRL 9 together with the SME.

Specification for use case

SMEs are invited to propose a use case leveraging their own technology or solving their problems at hand, which will be further elaborated together with the consortium partners. Inspirational examples can be based on system identification, parameter estimation, force estimation, etc. The consortium offers low-TRL research lab playgrounds as well as one high-TRL industrial application (as detailed above). SMEs applying for this challenge should specify which TRL level they would like to target. For the industrial application, three consortium partners will support SMEs in developing an augmented sensing solution to optimize the mold adjustment phase, targeting difficult-to-measure quantities and ensuring a comprehensive understanding of the manufacturing process. The data will be fed to an AI-based digital twin decision support tool, enabling first-time-right adjustment of the mold by the operator.

Expected solution

Currently, two operators visually inspect specific control points at the end of the production line and perform the necessary operations. The operators decide whether the refrigerator cabinets meet the required quality standards. However, there are no predefined measurement gauges, objective criteria, or tolerance limits in

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place. As a result, the process is highly dependent on operator experience and is therefore prone to human error and inconsistency.

Cabinets that pass the quality inspection are transferred to the next station for completion of the remaining operations. Non-conforming cabinets are diverted to a separate conveyor line for further inspection, rework, and repair activities.

The objective is to implement an automated inspection and control station equipped with advanced sensors and camera systems. When the cabinets arrive at the control point, the sensors and cameras will automatically inspect all predefined quality parameters. The system will analyze and display all inspection results in real time on a monitoring screen, while simultaneously storing all collected data in a centralized database for traceability and further analysis.

All inspection criteria, tolerance limits, and quality parameters will be defined in collaboration with the Quality Department of Arçelik.

Key Performance Indicators

Key Performance Indicators (KPIs) should clearly demonstrate the relevance and impact of the proposed solution. They must address at least two of the following dimensions: resource optimisation, Green Deal objectives, and social impact. All KPIs must be must be SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project.

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