Combined AI and Data solutions for creation of INSIGHTS

Challenge 2.2

Automated monitoring hygiene inspection for refurbishment

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2.2 Automated monitoring hygiene inspection for refurbishment

Challenge and context

Currently, within the consortium, Arçelik handles approximately 70,000 returned or rejected products per year. These products are processed through an automated sorting system in which each unit is scanned via a QR code, providing access to its complete historical documentation and traceability information, including an initial assessment of its refurbishment potential. For products identified as suitable for refurbishment, cleanliness and surface condition are assessed individually using swab tests and ATP detectors, requiring approximately 30 minutes per product. Although effective, this approach is time-consuming, provides limited spatial information, and does not support predictive or scalable, data-driven decision-making. The main challenge, therefore, lies in improving how cleanliness, sanitation, and surface condition are assessed in manufacturing and refurbishment processes, while reducing inspection time and supporting objective refurbishment decisions.

Use case and expected solution

This use case focuses on the development of an AI-based decision-making model to objectively determine the cleanliness status and surface condition of manufacturing equipment and parts. The proposed solution combines AI with optical sensing technologies to enable contactless, scalable, and industrially applicable cleanliness monitoring.
Multispectral and hyperspectral vision, together with infrared thermography, can be used for the early assessment of cleanliness and hygiene conditions in manufacturing and refurbishment environments. Hyperspectral imaging (HSI) enables the capture of objective, spatially resolved information on surface contamination, including organic residues (e.g. proteins, fats, and sugars), moisture, and cleaning-agent residues, over large areas and without physical contact. Infrared thermography (IRT) complements this capability by identifying temperature anomalies associated with residual moisture, improper cleaning, or incomplete drying processes. Compared to conventional RGB imaging, multispectral and hyperspectral data provide significantly richer spectral information, enabling more reliable discrimination of surface conditions and contamination types. Currently, LEITAT has the HSI and IRT systems available under laboratory conditions to develop a proof of concept of an AI-based predictive model for cleanliness assessment at TRL 4. Arçelik will provide the industrial playground, contributing real manufacturing equipment and parts to train the models and supporting their validation under real industrial operating conditions.

Specification for use case

SMEs are invited to propose a use case that contributes to the development of an AI-based predictive model and demonstrates the capability to integrate and validate HSI- and/or IRT-based decision-making models in industrial environments, bridging laboratory developments and production-line implementation. In particular, the consortium is interested in engaging SMEs capable of providing and deploying multi/hyper-spectral imaging (HSI) cameras or proposed optical sensing technologies for testing and validation under real industrial operating conditions. The consortium offers a low-playground, provided by LEITAT, where optical sensing technologies and AI-based decision-making models can be developed and validated under laboratory conditions, and a high-playground, provided by Arçelik, where the developed solutions can be tested, integrated, and validated under real industrial operating conditions.

Expected solution

AI-based, contactless inspection system that assesses the cleanliness and surface condition of manufacturing equipment and refurbished products by combining hyperspectral imaging (HSI) and, where

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applicable, infrared thermography (IRT). The system will generate objective, spatially resolved cleanliness indicators by detecting organic residues, contamination, moisture, and cleaning-agent residues over large surface areas, supporting automated and data-driven refurbishment decisions. Developed initially as a proof of concept under laboratory conditions at LEITAT (TRL 4), the solution will be integrated and validated in real industrial environments with TRL 9 at Arçelik, enabling scalable deployment in manufacturing and refurbishment processes while reducing inspection time, costs, and waste.

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 SMART (Specific, Measurable, Achievable, Relevant and Time-bound), ensuring they remain quantifiable throughout the project.

Resource optimization

- Inspection time per day: Reduced from ~2hours (ATP/swabs) to minutes using AI-based optical inspection
- Labour efficiency: ~126,000 labour hours saved per year (based on 70,000 units)
- Spare part recovery efficiency: Increase to 90% for refurbishment-eligible products
- Annual cost savings: Approx. €13.6 million/year (avg. product value €130)

Green Deal impact

- Impact: Returned products reused ~70,000 units/year refurbished instead of discarded
- Material savings: Approx. 7,000 tonnes of material saved/year (≈100 kg per unit)
- Reduction in consumables: Decrease in swabs, reagents, water, and cleaning chemicals
- Carbon footprint reduction: Lower emissions due to reduced new manufacturing and logistics

Social impact

- Worker safety & ergonomics: Reduced repetitive manual inspections via contactless sensing
- Workforce upskilling: Introduction of AI-based inspection and decision-support tools
- Job quality: Shift from manual inspection tasks to higher-value supervisory roles

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