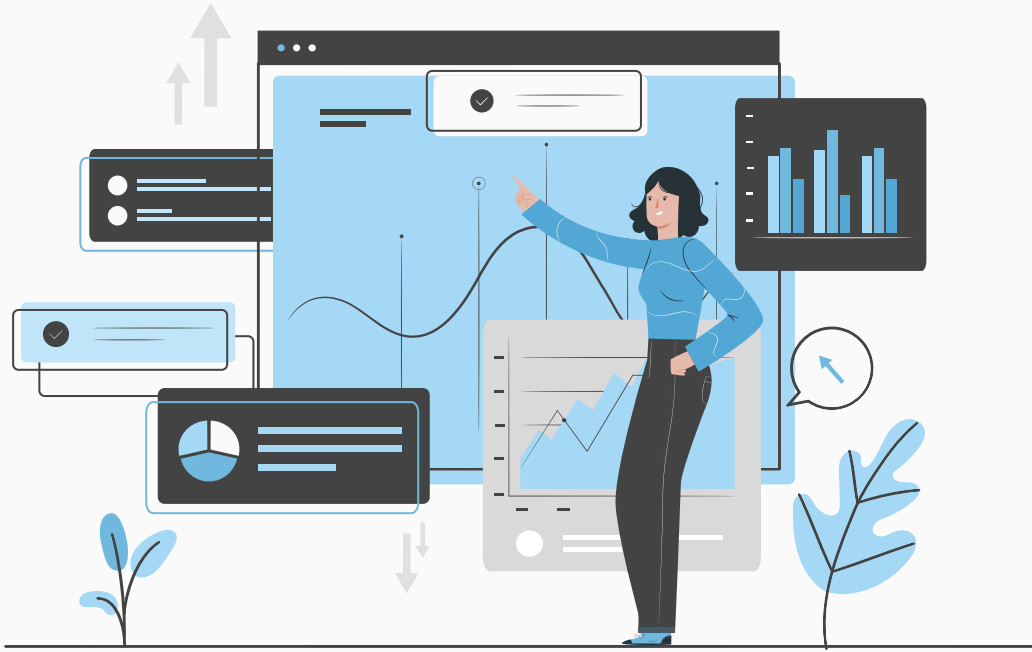
AI REDGIO 5.0

AI REDGIO 5.0 1st Open Call for experiments

14th December 2023



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AI REDGIO 5.0

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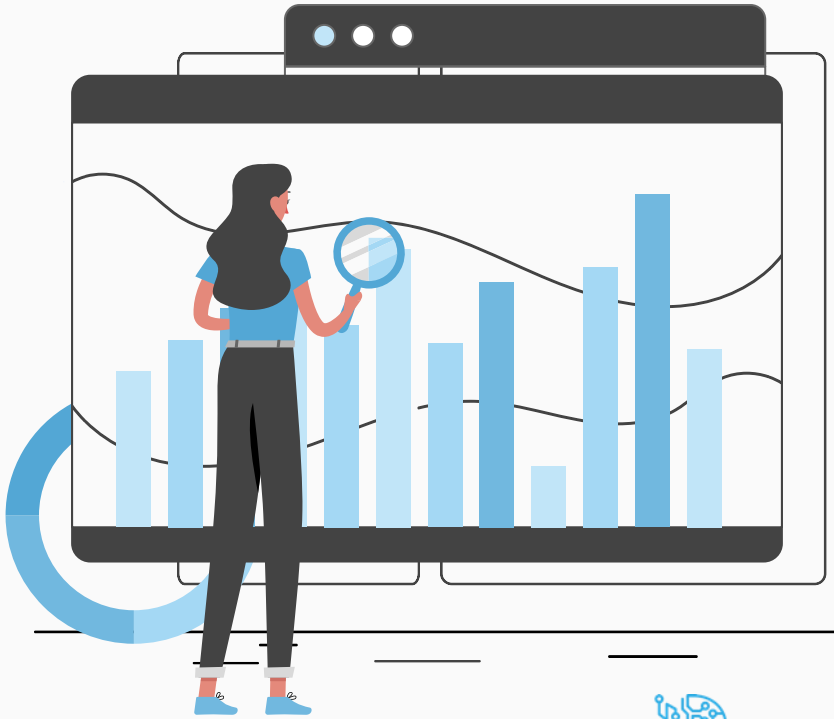
AI REDGIO 5.0: Context and objectives

Sergio Gusmeroli, POLIMI



AI REDGIO 5.0

TWIN TRANSITION 01-06 I4MS2

HORIZON-CL4-2022-TWIN-TRANSITION-01-06: ICT Innovation for Manufacturing Sustainability in SMEs (I4MS2) (Made in Europe Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio covering all technology areas, grants will be awarded to applications not only in order of ranking but also to at least one project per technology area, provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The maximum amount to be granted to each third party is EUR 60 000. The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

AIRISE.EU

Artificial Intelligence in Manufacturing for Sustainable Applications at SMEs.
The AIRISE project will support European SMEs in the uptake of Artificial Intelligence applied to manufacturing, with a specific focus on the use of AI-enabled applications at the edge. Call for Ambassadors closed end JUL (LMS PBN)

White-label shop for digital intelligent assistance and human-AI collaboration in manufacturing.
WASABI aims at providing SMEs with the tools and knowledge to improve workers capacities and performance, providing advanced user interfaces for continuous augmented hybrid-decision-making. Such interfaces assist employees in interacting with complex software, effectively reducing its skill floor. (CARSA)

CIRCULOOS

Circular and Dynamic Manufacturing Supply Chain Orchestration and OptimiSation.
CIRCULOOS aims to deliver circular manufacturing tools which orchestrate and continuously optimise the supply-chain end-to-end and comprehensively integrate planning and execution. (ED, FIWARE, RAMP)

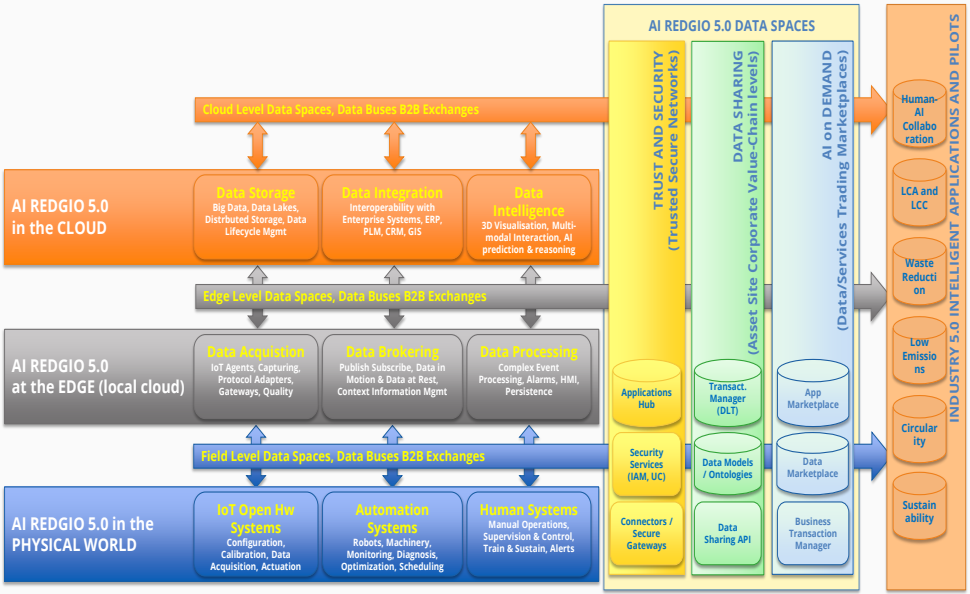
AI REDGIO 5.0

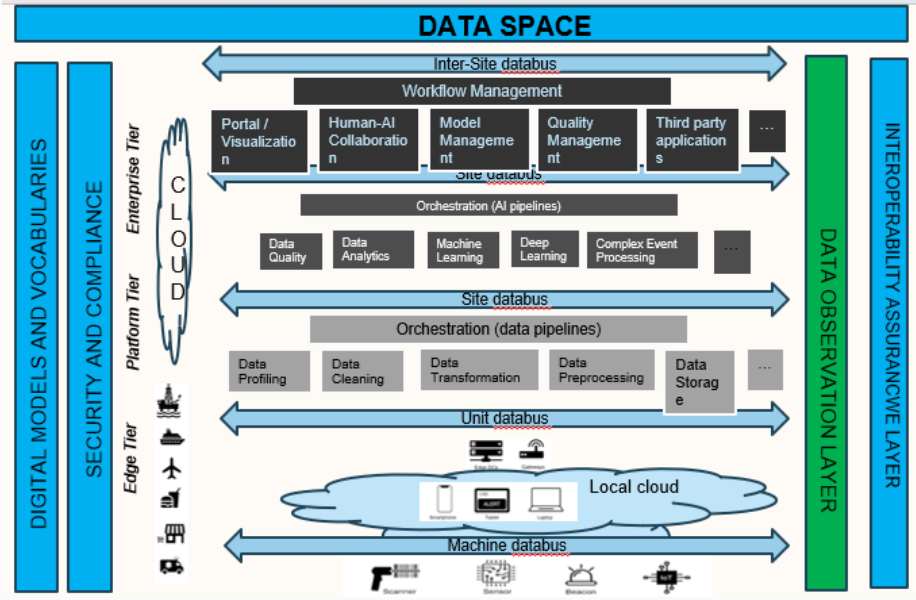
Regions and (E)DIHs alliance for AI-at-the-Edge adoption by European Industry 5.0 Manufacturing SMEs

AI REDGIO 5.0

Objectives

1 CONCEPTUAL FRAMEWORK AND REFERENCE ARCHITECTURE FOR AI-AT-THE-EDGE INDUSTRY 5.0 APPLICATIONS AND EXPERIMENTATIONS





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Objectives

2

SECURE AND TRUSTWORTHY EDGE-TO-CLOUD CONTINUUM DATA AND COMPUTATIONAL SPACE FOR HIGHLY DISTRIBUTED AI APPLICATIONS

BONSEYES

AI REDGIO 5.0

Objectives

3 INTEROPERABILITY BY DESIGN WITH THE PAN-EU AI-ON-DEMAND PLATFORM AND ITS ECOSYSTEM OF H2020 & HEP INNOVATION ACTIONS

Strengthening Digital Innovation Hubs with the European AI-on-demand platform: Recommendations White Paper

What precisely will be the nature of the relationship and interactions between the pan-European on-demand platform and the regional (E)DIHs? What value can they offer one another? And how will they work together to serve the interests of the respective and sometimes overlapping stakeholders?

AI REDGIO 5.0

Objectives

4

SUPPORTING THE EUROPEAN WAY TO AI FOR MANUFACTURING BY GENUINE EU OPEN SOURCE FRAMEWORKS, IMPLEMENTING EU VALUES AND ETHICAL PRINCIPLES IN TERESA SANDBOXES

TERESA

«Mini Factory» TERESA

- **Switzerland**, connection with **SUPSI**
- **Human-robot collaboration through different small experiments** dedicated to Collaborative Robotics and Human-centred Production Systems, with **different scenarios** where a cobot and humans work together in **various tasks** (assembly, screwdriving) and with varying **degrees** of collaboration (separated and independent, sequential, synchronous, etc.)

«BIC – Factory of the Future Experience Center» TERESA

- **The Netherlands**, connection with **BI**
- Fast, flexible and faultless **assembly of different products**, with multiple experiments such as operator support system in a manual assembly workplace and handling machine data, production processes and information exchange along the chain

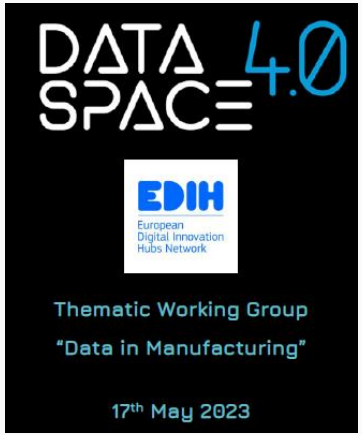
«SMILE@Lab» TERESA

- **Italy**, connection with **Intellimech**
- **LUISA** - nLp for troubleshooting System interAction: **computer-based troubleshooting system** that, starting from symptoms , determine the causes of the product or process **malfunctioning.** It includes dialogue with the operator (Speech-to-Text & Text-To-Speech Technologies), Automatically find fault component/failure mode, Understand the meaning of operator report Automatically Update questions & probability dataset

AI REDGIO 5.0

Objectives

5 MANAGE AND GOVERN THE TRANSITION FROM REGIONAL DIHS TO A NETWORK OF EDIHS IN AI FOR MANUFACTURING



Section 1 – Welcome and Motivation	
• *Present the motivation behind the creation of a common Thematic Working Group (TWG) to support the needs of the EDIHs network in the area of Digital transformation, Data & Manufacturing*	
10:00 – 10:10	Welcome (**Oscar Lazaro, Matthias Kuom**)
10:10 – 10:20	Digital Europe Context (**Matthias Kuom**)
10:20 – 10:40	TWG Context & Initial Mission (**Oscar Lazaro,**

Section 2 – EDIHs representatives' presentation	
• *Tour de Table of EDIHs joining the Thematic Working Group: Hubs* • *Moderator: **Maria Rossetti**)*	
10:40-11:00	EDIH pitches – motivation (**ALL**)

Section 3 – Data Space 4.0 presentation	
• *Introduction to Data Space Support Centre (DSSC) & Data Space 4.0 preparatory action*	
11:00 - 11:15	Designing and deploying global data value networks for manufacturing (***Oscar Lazaro***)

Section 4 – TWG operational procedures	
• *Initial vision for the joint activities of the TWG to be carried out, outcomes and how they will be delivered, tasks management and contacts*	
11:15 - 11:30	TWG collaboration and workplan co-creation process (**Maria Rossetti**)

Section 5 – Open discussion	
• *Participants insights, contributions and future outlook to shape the TWG*	
11:30 – 12:00	*Priorities & first opportunities for collaboration(**ALL**)*

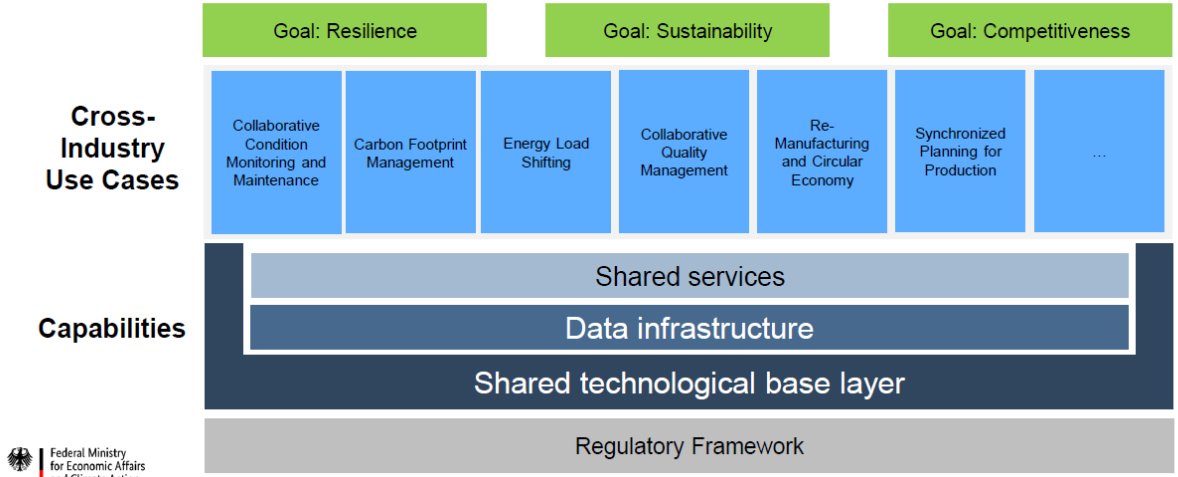
AI REDGIO 5.0

Objectives

6 TEST BEFORE INVEST EXPERIMENTS IN AI DIDACTIC FACTORIES AND TEF

Manufacturing-X Architecture

Manufacturing-X aims to implement important cross-industrial use cases on a common framework.



Federal Ministry for Economic Affairs and Climate Action

AI matters

INDUSTRIA-X the horizontal Data Sharing Space in a pan-eu network of Didactic Factories

AI REGIO

11 Didactic Factories representing 11 regions in the project. Plus additional DFs not related to AI REGIO Beneficiaries (SUPSI SSF). IIOT-AAS-DTWIN-xR-TELE experiments

DIMOFAC

9 Didactic Factories representing beneficiairies in the project (AIMEN(2) CEA(2) DFKI IPC TECNALIA SSF BRAINPORT LMS POLIMI)

Modul4r

3 Didactic Factories representing beneficiairies in the project (AIMEN SSF POLIMI)

DaCapo

8 Didactic Factories representing beneficiairies in the project (AIMEN CEA VTT POLIMI(2) LMS TNO UniMORE SUPSI)

Circular TwAIn

2 Didactic Factories representing beneficiairies in the project (POLIMI SSF)

RE4DY
MANUFACTURING DATA NETWORKS

3 Didactic Factories representing beneficiairies in the project (POLIMI INNOVALIA SSF)

AI REDGIO 5.0

14 Didactic Factories representing VANGUARD Regions in the project

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Objectives

7 VALIDATION AND EVALUATION IN SME-DRIVEN AI FOR MANUFACTURING USE CASES

1. REAL TIME MONITORING FOR CONTROL & DETECTION OF PRODUCTION SCAMM
2. AI AND DIGITAL TWINS FOR AGILITY IN MOULD MAKING PERNOUD
3. AI-BASED AUTONOMOUS MACHINE FOR SAFER FASTER AGRICULTURE GPALMEC
4. PREDICTIVE MAINTENANCE AND ZERO-DEFECT PRODUCTION OF MOULDS POLYCOM
5. AI-ENABLED DIGITAL TWINS FOR VIRTUAL COMMISSIONING QUESCREM
6. INTELLIGENT CONTEXTUALISED VISUAL SYSTEM FOR ERROR REDUCTION CAP
7. QUALITY ASSURANCE OF CLOTHING PRODUCTION KATTY FASHION

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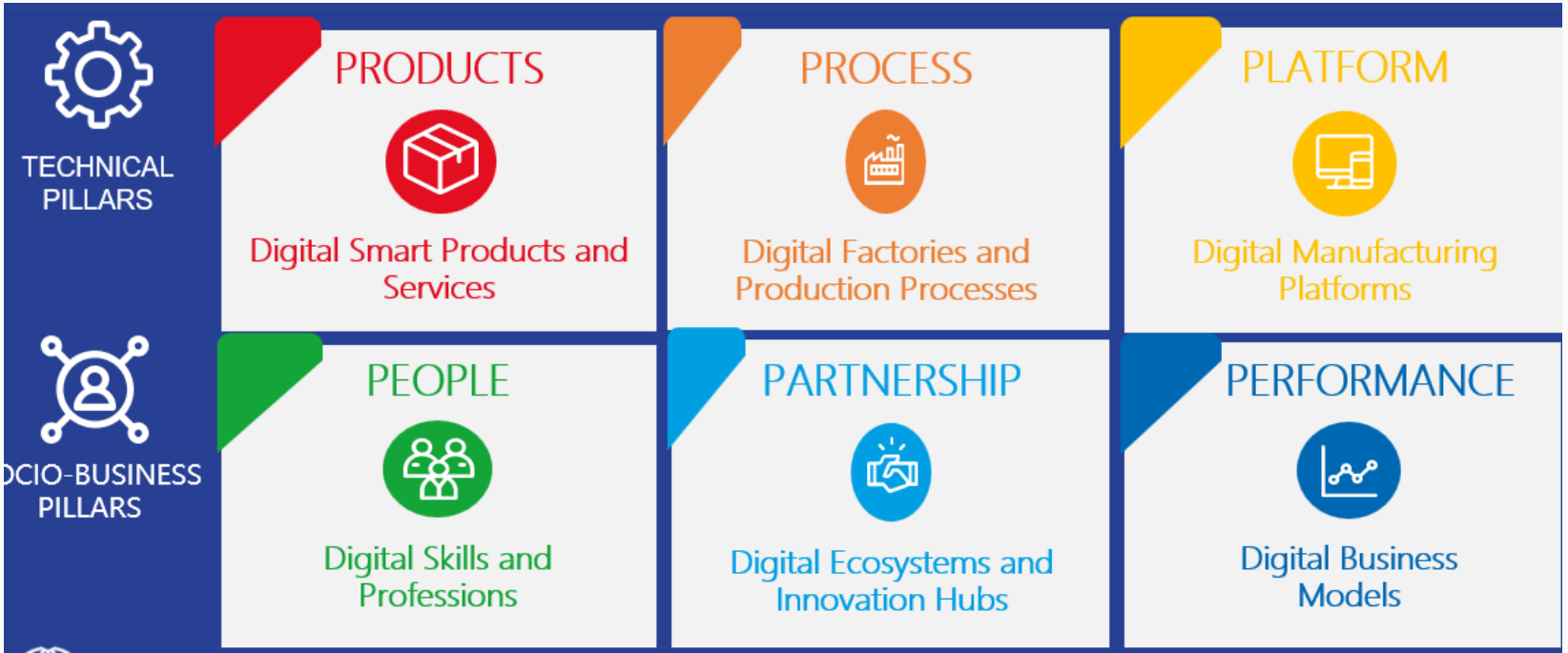
Objectives

8 AI-DRIVEN I5.0 DIGITAL TRANSFORMATION METHODS AND TOOLS, MATURITY ASSESSMENT, 6PS PATHWAY SPECIFICATION AND AI SKILLS FOR I5.0 DEVELOPMENT PROGRAM



AI REDGIO 5.0

Objectives

9 SUSTAINABILITY, ECOSYSTEM DEVELOPMENT AND REPLICATION TO SMES

Alliance for IoT and Edge Computing Innovation

The 7° P: Portability

PRODUCT — How much have the enablers of Replicability and Scalability been taken into account in the design of your Smart Products (if any) ?

PROCESS — How much have Replicability and Scalability of the processes been taken into account in the design of your pilot ? (Processes: Production, Quality Control, Maintaining, Logistics…)

PLATFORM — How much have the enablers of Replicability and Scalability been taken into account in the design of the digital platform supporting your pilot ?

PEOPLE — How much have the enablers of Replicability and Scalability in the User dimension been taken into account when designing your pilot ?

PARTNERSHIP — To what extent the Replicability and Scalability features of the pilot will benefit external stakeholders and partners who took part to the project (such as DIH, R&D Centres, Universities, IT suppliers, commercial partners) ?

PERFORMANCE — In addition to the KPIs developed for the pilot, have you set up new KPIs, foreseeing its replication or scaling-up?

OBJECTIVE:
To support the replicability and the scalability of R&I project platforms to other industrial domains or larger scale

TOPIC 1: AI at the Edge applications and edge-to-cloud continuum

AI plays a significant role for almost any industry and the same is a reality for manufacturing. In AI REGDIO 5.0 the main goal is to showcase the advantages AI can bring to manufacturing enterprises when this is performed **at the edge**, making use of the edge-to-cloud continuum, capitalising on the capabilities that are today offered by novel cloud-to-edge execution frameworks and infrastructures, as well as AI models and libraries that are in a position to realise local execution. Using such approaches manufacturing industries and SMEs are able to grasp all the benefits that accompany this approach (e.g., low latency, minimal data transfer, data sovereignty and privacy, etc.).

Experiments to be selected should demonstrate the above-mentioned approach, with providing real-life use cases that call for AI execution at the edge, or using hybrid cloud-edge infrastructures, and building the necessary services and AI models to realise this target. Experiments shall design the necessary AI pipelines to execute their use cases, and local execution of the AI models should be performed on edge computing environments, such as the one specified by the *AI-REDGIO Open Hardware* or similar, which applicants have to deploy. Moreover, the re-use (and at a later experiment stage the publication) of AI models to the *AI-on-Demand platform* is strongly encouraged.

Applications of interest include, but are not limited to, the use of AI for predictive and prescriptive maintenance, automation, manufacturing operations planning and scheduling, waste reduction, energy efficiency, resource optimisation, quality control, circularity, resource optimisation, etc.

In all experiments, applicants should clearly showcase how Human-AI teaming can be achieved in their use case, where AI and human interaction are blended to benefit both the AI system, as well as human operators.

TOPIC 2: Industry 5.0 and human-centric, resilient and sustainable manufacturing

Whereas Industry 4.0 advocates the fostering of industrial activity that transcends technical and economic objectives such as productivity and efficiency, Industry 5.0 seeks to promote other purposes that are also essential for the future of the sector, i.e., human well-being, sustainability, and resilience. Industry 5.0 is a model of the next level of industrialization characterized by the return of manpower to factories, distributed production, intelligent supply chains, and hyper customization, all aimed to deliver a tailored customer experience time after time.

Experiments to be selected should explore how Industry 5.0 and human-centred digitalization can contribute to the flexibility and adaptability of small and medium-sized enterprise (SME) production processes, resulting in more resilient and sustainable systems. The goal is to explain on real use cases the relationship between digital technologies and production system features through progressively more human-centric stages of a digitalized manufacturing system. Experiments should focus on measurable benefits in Industry 5.0 context, such as improving well-being of workers, creating safer workspace, improved ability to adapt to adverse situations with positive results, reducing negative environmental aspects in the entire product life cycle.

Applicants are encouraged to adopt AI REDGIO 5.0 reference architecture (RA) for providing end-to-end solutions. Proposals in this topic shall provide clear business scenarios, reflecting real industry challenges and defining and measuring realistic technical and business KPIs. In this perspective, it is expected that the application experiments provide their own datasets and the commitment of Manufacturing SMEs to define and measure the business benefits from AI REDGIO 5.0 RA.

TOPIC 3: TERESA (TEchnology REgulatory SAndboxes) experiments

In the Industry 5.0 workplace of the future, envisioned by AI REDGIO 5.0, humans and machines are expected to share physical spaces according to the cutting-edge **Collaborative Intelligence** paradigm, working not only sequentially but even with close, physical real-time responses from machines/robots to the operators. The AI-driven autonomous systems will efficiently and effectively interact with the human beings, enabling an immersive AI-based human-machine co-working environment. The work has a pivotal role in most adult lives. Therefore, the ethical, regulatory, psychological and societal impacts of the introduction of Industry 5.0 and CI solutions in the workplace must be taken into account: it is paramount to perform experimentations to ensure that both industrial companies and workers benefit from the advantages of a synergistic collaboration between humans and machines and that the workers (and their rights) are put at the center of the factory, moving ahead towards the ethically-sound and human-centered human-machine co-working environment.

In order to promote the data-and-human-oriented SME digital transformation, the AI REDGIO 5.0 Project is extending the AI REGIO Network of **Didactic Factories** (DFs). In synthesis, an AI REDGIO 5.0 DF is an open testing and experimentation facility which extends the services of a Learning Factory towards the materialization of the EDIH "test before invest" pillar. By providing access to technical expertise and experimentation as well as the possibility to "test before invest", A Didactic Factory, like an EDIH, helps companies innovating their business or production.

The main goal of Topic 3 proposals is to develop a TEchnology and REgulatory SAndbox (TERESA) experiment, exploiting a DF's facilities* and addressing Human-AI interactions and regulatory and ethical issues. The experiments to be selected under topic 3 must cover one or more of the Topics 1 and 2, following the "humans in the loop" train-explain-sustain paradigm. The TERESA experimentation should have a twofold objective: i) a technical validation of the Human-AI interaction through a DFs, following the test-before-invest paradigm, and ii) a regulatory and ethical validation, involving volunteers and at least a competent authority (such as regulators, supervisors, policy-makers, innovation agencies, Vanguard Initiative representatives, regional or local authorities, etc.).

*The full list of Didactic Factory facilities in AI REDGIO 5.0 can be found on our project website: https://www.airedgio5-0.eu/didacticfactoriesexperiments

AI REDGIO 5.0 1st Open Call: topics

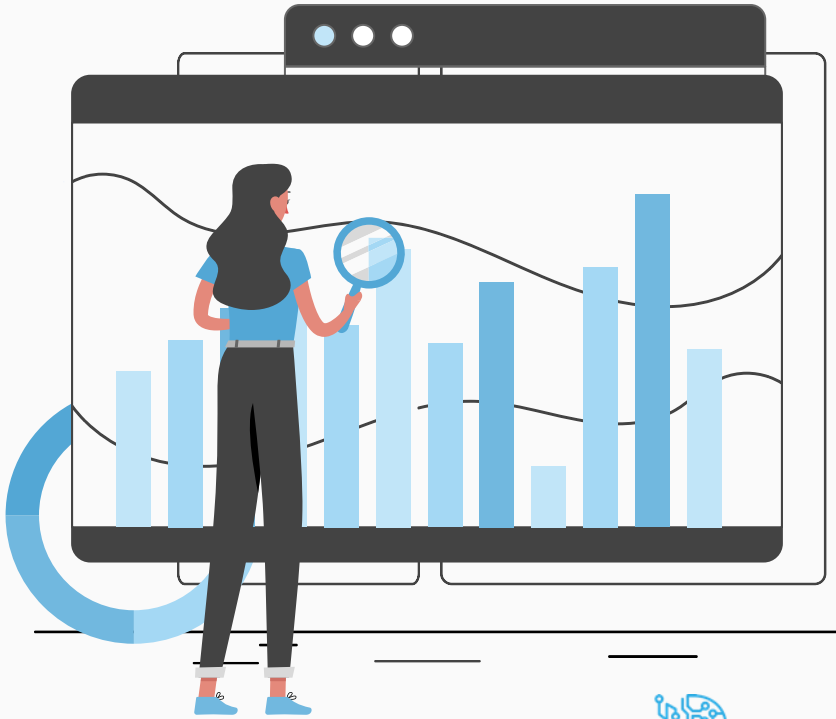
TOPIC 3: TERESA (TEchnology REgulatory SAndboxes) experiments

One or more of the following so-called WISE aspects have to be addressed by the TERESA experiment:

- Well-being, Comfort and Acceptance, which refer to the impact on mental well-being and self-esteem, frustration, feeling of usefulness, emotional dependence and overconfidence on the machine, human dignity, autonomy and oversight, concerns/willingness in collaborating with a machine;
- Inclusion and special categories of workers, which refers to the effects on older workers, effects on novices, effects on workers with cognitive or physical disabilities/impairment, social isolation, risk of discrimination/bias;
- Safety of the worker, including health and safety of the workers, risks of harm, privacy and other.
- Ergonomics and improving working conditions, comprising the impact on stress reduction, fatigue reduction, effects on workers' skills.

AI REDGIO 5.0 1st Open Call

Naia Muruaga, CARSA



AI REDGIO 5.0

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AI REDGIO 5.0 1st Open Call

OBJECTIVE: The objective for the first open call of AI REDGIO 5.0 project is to select **up to 10 SME-driven experiments** focused on the **implementation of AI at the Edge and Industry 5.0 systems** with the aim of improving existing solutions, products or processes in the **manufacturing area**. Additionally, the open call will contribute to extend the domains of AI REDGIO 5.0 and benefit directly manufacturing SMEs and small mid-caps.

NB TOPIC 3: If the applicant chooses to conduct the experiment at one of the AI REDGIO 5.0's DF's premises, they should indicate it at proposal stage which DF they wish to join. Make sure to include in your budget any foreseen travel costs.

The complete list of DFs part of the AI REDGIO 5.0 project can be consulted here:
https://www.airedgio5-0.eu/didacticfactoriesexperiments

REQUESTED FUNDING

Up to EUR 60k per experiment

FUNDING RATE

For profit entities: 60% of eligible costs
Non-profit entities: 100% of eligible costs

PAYMENTS

Pre-financing: 50%
Final payment: 50%

TOPICS

- **TOPIC 1:** AI at the Edge applications and edge-to-cloud continuum
- **TOPIC 2:** Industry 5.0 and human-centric, resilient and sustainable manufacturing
- **TOPIC 3:** TERESA (Technology Regulatory Sandboxes) experiments

DURATION

8 MONTHS: May 2024 – January 2025

AI REDGIO 5.0

AI REDGIO 5.0 1st Open Call

Who can apply?

The AI REDGIO 5.0 open call is addressed to manufacturing SMEs eligible for Horizon Europe. Only one proposal will be accepted for each SME.

ELIGIBILITY CRITERIA

- Based in an EU 27 Member State or Horizon 2020 Associated Countries[1].
- The Proposal must be submitted in English.
- The Proposal must be submitted within the stipulated deadline.
- Complete the application following the template provided.

1 https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/common/guidance/list-3rd-country-participation_horizon-euratom_en.pdf

What is in AI REDGIO 5.0 for the participants?

The selected experiments will benefit from:

- Financial support of **up to: EUR 60.000 per experiment;**
- Taking advantage of existing AI in the Edge components and AI at the Edge expertise for manufacturing already available in AI REDGIO 5.0 consortium;
- Extend and improve the AI REDGIO 5.0 catalogue of advanced AI at the Edge components and tools;
- Participate in innovative experiments in the domain of AI at the Edge for Manufacturing.

AI REDGIO 5.0

AI REDGIO 5.0 1st Open Call

KEY DATES

Activity	Dates
Call opening	01/12/2023
Call closing	01/03/2024 – 12:00 CET
Assignation of evaluators	19/02/2024-08/03/2024
Evaluation of proposals	11/03/2024 – 14/04/2024
Communication of results	15/04/2024-22/04/2024
Sub-grant Agreements	23/04/2024 – 19/05/2024
Execution of experiments	20/05/2024-19/01/2025

AI REDGIO 5.0 1st Open Call

SUPPORTING DOCUMENTATION

The AI REDGIO 5.0 1st Open Call supporting documentation includes:

GUIDE FOR APPLICANTS

AI REDGIO 5.0

AI REDGIO 5.0 OPEN CALL 1

Guide for applicants

Person responsible / Author:	CARSA
Deliverable N.:	-
Work Package N.:	WP1
Date:	01/12/2023
Project N.:	101092069
Classification:	Public
File name:	AI REDGIO 5.0 OPEN CALL 1: Guide for applicants
Number of pages:	17

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FREQUENTLY ASKED QUESTIONS DOCUMENT

AI REDGIO 5.0

AI REDGIO 5.0 OPEN CALL 1

Frequently Asked Questions (FAQs)

Person responsible / Author:	CARSA
Deliverable N.:	-
Work Package N.:	WP1
Date:	
Project N.:	101092069
Classification:	Public
File name:	AI REDGIO 5.0 OPEN CALL 1: Frequently Asked Questions (FAQs)
Number of pages:	9

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PROPOSAL TEMPLATE

AI REDGIO 5.0

AI REDGIO 5.0 OPEN CALL 1

Proposal template

Person responsible / Author:	CARSA
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Work Package N.:	WP1
Date:	
Project N.:	101092069
Classification:	Public
File name:	AI REDGIO 5.0 OPEN CALL 1: Proposal template
Number of pages:	

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EVALUATION AND SELECTION PROCESS

01 – EXCELLENCE	02 – IMPACT	03 – IMPLEMENTATION
• Clear objectives; • Alignment with AI REDGIO 5.0 objectives; • Address the sectors and technologies of AI REDGIO 5.0; • Develop a sound and ambitious experiment consisting on an end-to-end solution, starting from connecting data sources, till “action handling”; • Clear description of the challenge; • Present a draft of the architechture; • Demonstrate innovation capacity to improve the current processes, products or services.	• Contribute to increase the digitalisation level of the SME. • Demonstrate clear technological, economic and commercial impacts. • Set clear and realistic KPIs. • Develop an appropriate dissemination and exploitation plan.	• Develop a coherent and clear work plan. • Have the required capacity to carry out the experiment (budget). • Demonstrate capacity to carry out the experiment (personnel, infrastructure, etc.).

EVALUATION AND SELECTION PROCESS

PREPARATION OF THE PROPOSAL

Complete the proposal template, which can be downloaded from the EMS platform.

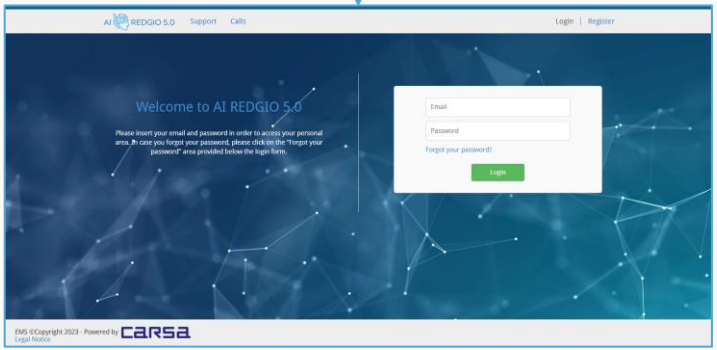
SUBMISSION OF THE PROPOSAL

The proposals will be submitted digitally in a single-stage through the Evaluation Management System platform (EMS).

EVALUATION AND SELECTION

The proposals received will go through the following evaluation process:

- Eligibility check;
- Evaluation; → Excellence, Impact, Implementation
- Ranking and final selection.



AI REDGIO 5.0

AI REDGIO 5.0 1st Open Call

IMPORTANT DATES:

Information is available on the AI REDGIO 5.0 website and EMS platform:

- ✓ Call general details;
- ✓ Supporting documentation;
- ✓ Thematic areas.

AI REDGIO 5.0 Website:

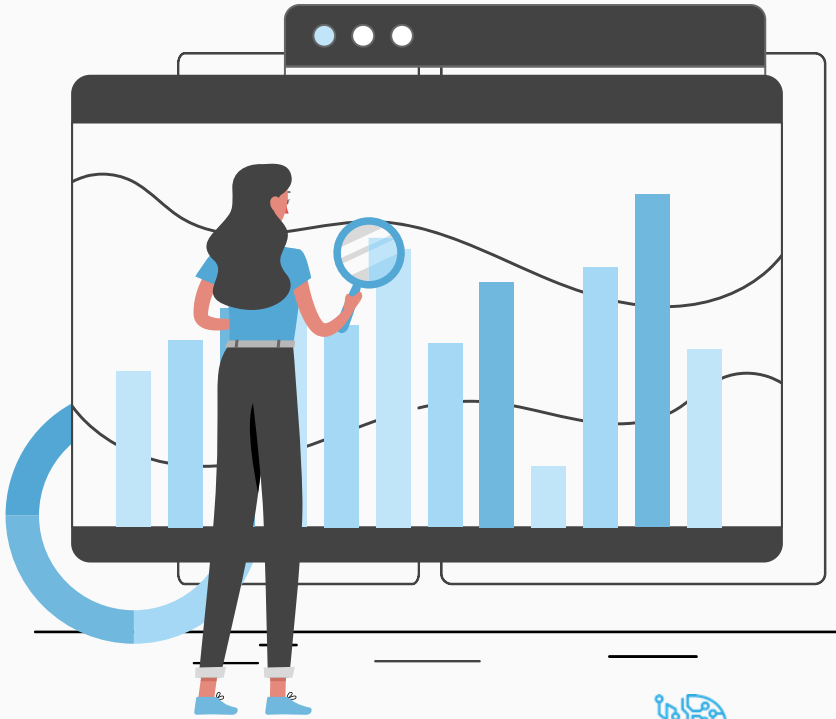
https://www.airedgio5-0.eu/open-call-1

EMS platform:

https://airedgio.ems-carsa.com/login

AI REDGIO 5.0: Inspiring experiments

Katty Fashion, Romania
Aalborg University, Denmark



AI REDGIO 5.0

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Industrial Experiment VII
Katty Fashion
Quality Assurance of clothing production

Ionel AUNGURENCEI
kf.tech@katty-fashion.ro
Katty Fashion SRL, Iași, Romania

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Experiment team

TUI and **KAF** work together to analyze the QA process and refine the requirements that are used by TUI to create the QUAD-AI@Edge system to be used in the QA department by KAF team.

During **AI REDGIO 5.0,** Katty Fashion will be the end user of the **implementation of the QUAD-AI@E solution, developed by TUI, in the real clothing manufacturing environment.** More specifically, we will working together with TUI Iasi in **developing an AI that can detect fashion product defects**.

TUI (”Gheorghe Asachi” Technical University Iasi, Romania)

technology provider/DAF

TUI has access to complex and complete technical information, viable and tested from the entire process, for the creation of the system for the improvement of the QC control stage.

KAF (Katty Fashion SRL, Iasi, Romania)

end-user application experiment SME.

Katty Fashion has vast experience in the textile field, comes in TUI support to explain in detail the manufacturing process that ends with the quality control of the product, a particularly important stage to provide results at high standards.

Katty Fashion brief presentation

KAF (Katty Fashion SRL, Iasi, Romania):

end-user application experiment SME.

Katty Fashion was founded in **2003** and has 2 decades of expertise in offering bespoke flexible **high-end manufacturing services** for all categories of womenwear for over **50 EU brands** with worldwide whole-sale.

Winner of C-voucher competition in 2019 and **BoostUP Transform** CLC East EITM Competition in 2020.

Katty Fashion

Because We Kare

Relevant projects:

- **AIRedgio 5.0 - AI-powered QC**
- R3GROUP - Digital Twin of process and product through IIoT and digitalization
- RegioGreenTex - zero waste & circular
- DIH-World - smart virtual prototyping
- KARE - Demo Lab towards Fashion Factory of the future

Experiment team

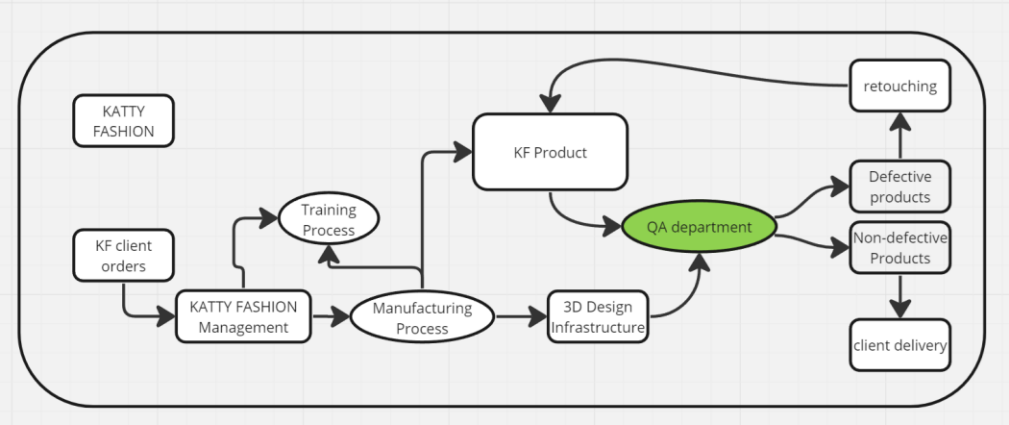
"Gheorghe Asachi" Technical University of Iasi – medium size public university

- 11 Faculties and a Doctoral School
- 140 Study programs (BSc and MSc) and 13 doctoral programs
- 13000 students and 800 PhD students
- 630 academic staff and full time researchers
- 24 research centres
- 1 Technological Transfer Office
- 400 journal papers/year (WoS ranked)
- 50 EU projects during last 5 years
- 1800 patents in TUI portfolio
- 5 spin-offs

General description and motivation

Motivation - problems, gains and pains:

The **KAF Quality Assurance department** inspects the product quality last, and if a defect is found there, the customer will be dissatisfied. **QA work is currently done manually** using a detailed checklist with subjective evaluation. **AI can simplify QA** tasks and **improve process efficiency and objectivity**. In order to fully build the **Fashion Factory of the Future**, this adds to KAF's strategy for transformation to a digitally enabled smart & circular business model in fashion industry.



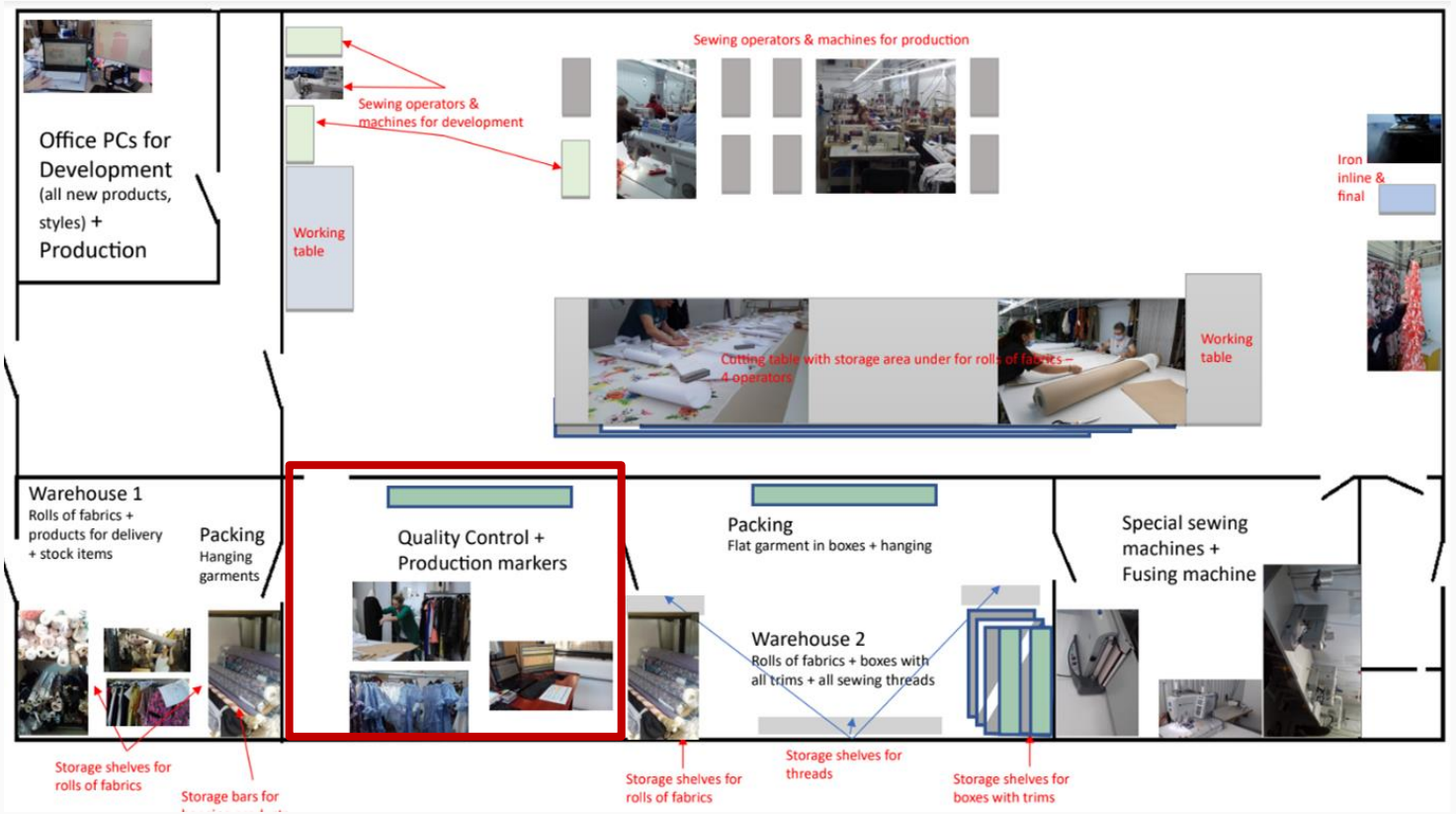
AS-IS scenario - manual checks done to verify quality

Experiment concept:

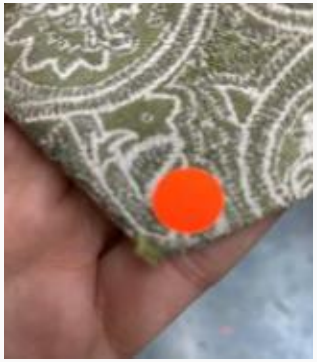
Development of a product defect detection system with the following functionalities: **acquire product images; manipulate images by an embedded AI tool; extract information about the nature and severity of the product defect; send alert to the QA personnel in charge of the product check**. The developed system should be able to assist the QA team in validating the correctness of the operations done for the analyzed item based on close integration with the initial design characteristics.

General description and motivation

Site: The experiment will be implemented in QC room of the KAF factory and will be integrated in existing production workflow and internal custom cloud platform (MES + PLM + ERP).



Experiment's Implementation status



Preliminary defects classification

a) the non-linearity of the seams

b) fringing the textile

c) stains on fabric

d) buttons wrong placement

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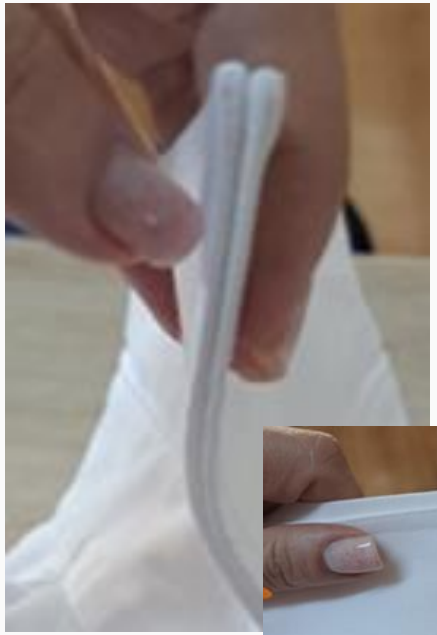
Experiment's AS-IS - defect examples

- Uneven collar
- Wrong collar shape



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Experiment’s AS-IS - defect examples




- Wrongly oriented plies
- Incorrect bordage

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Experiment’s AS-IS - defect examples

- Geometric error for bottom lines of the pocket
- Improperly applied pockets; asymmetrical flaps; incorrect pocket corners
- Flaps of different widths and unevenly tiled

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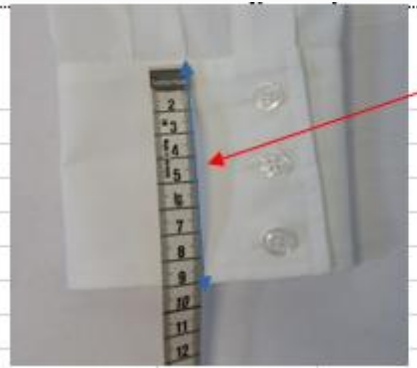
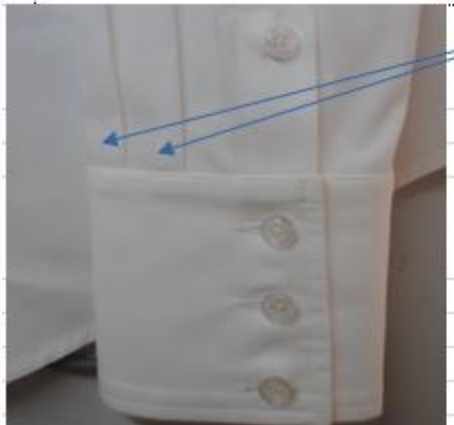
Experiment's Implementation - QA checks

the corners of the collar should be symmetrical in shape and size

symmetrical sleeve pentagon equal in length and width



the cuffs are symmetrically equal in length and width



sleeve folds oriented towards the slit symmetrical left / right with the same depth

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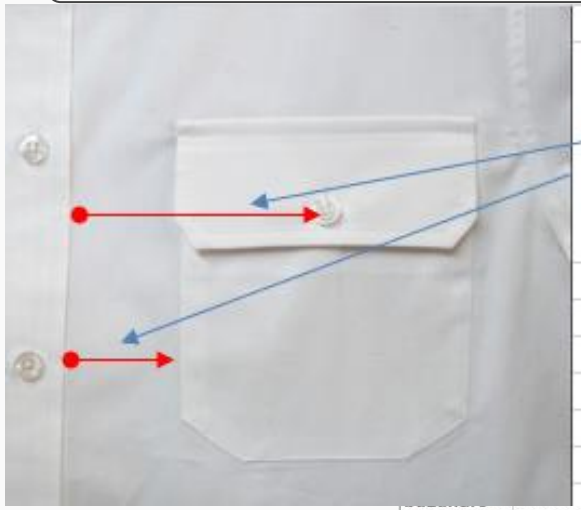
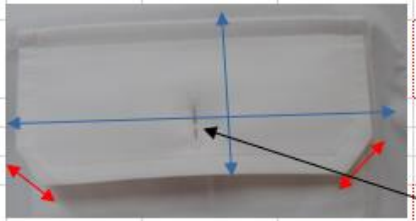
Experiment's Implementation - QA checks

the buttonholes/buttons positioned in the middle of the front slit, at the same distance according to the specifications with accepted tolerances and checking in accordance with the sample

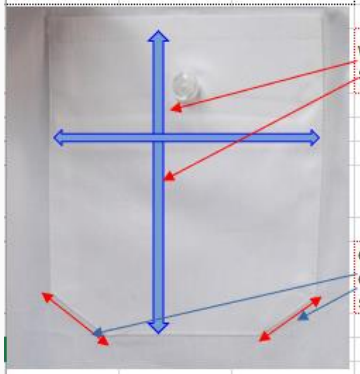


the pockets must be correctly applied at the same distance from the center of the face; check the symmetry of the positioning of the pockets in front of the center in accordance with the validated sample



flaps with symmetrical width/height between them

correct positioning of the buttonhole on the flap



width/height of symmetrical pockets

corners made with the correct geometric shape symmetrical to each other

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General description and motivation

The experiment has 5 main phases:

- **Scenario Analysis. Establishment of the Hardware and Software architecture:** identify, analyze, document, and manage the needs and expectations of the QA team that will use the the developed system
- **Business/Technological Requirements, elicitation and analysis.** modeling business operations, identifying both business and technological needs, prioritizing experiment requirements, and validating those requirements.
- **Technical Requirement Specification and AI-focused architecture design:** identification of technical requirements for system components, the design of an AI-focused architecture, and the subsequent validation of the system architecture.
- **Deployment and verification.** the creation and integration of hardware and software components, including AI algorithms for defect detection and simulation functions, leading to the testing and validation of both an experimental model and a prototype, system validation, followed by iterative system improvements.
- **Requirement validation, assessment and lessons learned.** creating a database of clothing defects, delivering image capture equipment, capturing and storing defect images, using this database for AI training to identify defects in new images, assessing experiment requirements, and sharing lessons learned and results.

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Objectives and benefits

With the **QUAD-AI@Edge** system, KAF QA department **can optimize the quality checks processes** by **leveraging AI-powered automation** without **disrupting current workflow.**

The **system** offers the ability to **boost clothing quality control** through **seamless defect detection** with **minimal manual intervention.**

Objectives	Benefits
Automated QA process	Objective and complete QA report for clients
Minimise the chance of producing substandard products	High quality products delivered to clients
Reducing loss and wastage in the production	Less pollution, lower production costs
Increasing the cadence of quality analysis	Reduce time waste: increase the pace of the quality analysis process from 15-20 minutes to a maximum of 5 minutes/product
Avoiding the transfer to the market of defective products	Ensuring a superior quality of the analysis through the system
Make related jobs more attractive for humans	Larger hiring pool, higher wages due to better specialization
Eliminating repetitive tasks and monotony	Lower employee burnout, the support granted to a human operator; visual analysis of defects by a human operator is tiring, requiring very good visual acuity and a good ability to concentrate
Making it possible for the same tasks to be performed, but with fewer hours of labour.	Productivity increase

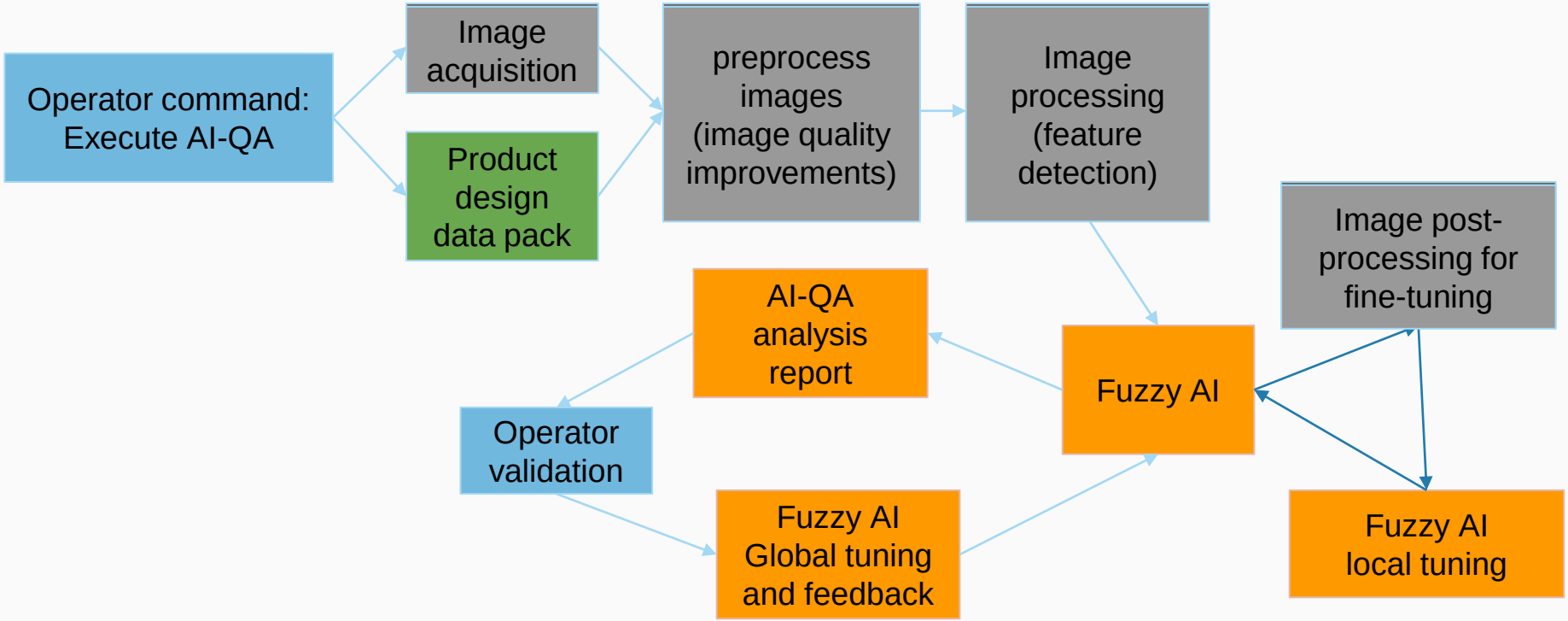
Experiment’s Implementation status

STATE OF THE ART – defining the concept

The concept underpinning **QUAD-AI@Edge experiment** is the development of a **product defect detection system** with the following functionalities: to acquire product images; to manipulate images by an embedded AI tool; to extract information about the nature and severity of the product defect; to send alert to the QA personnel in charge of the product check. The experiment builds on integrating AI at the edge technology into a product defect detection system prototype suitable for quality control automation in textiles industry.

Technical solution (software)

Experiment's Implementation status



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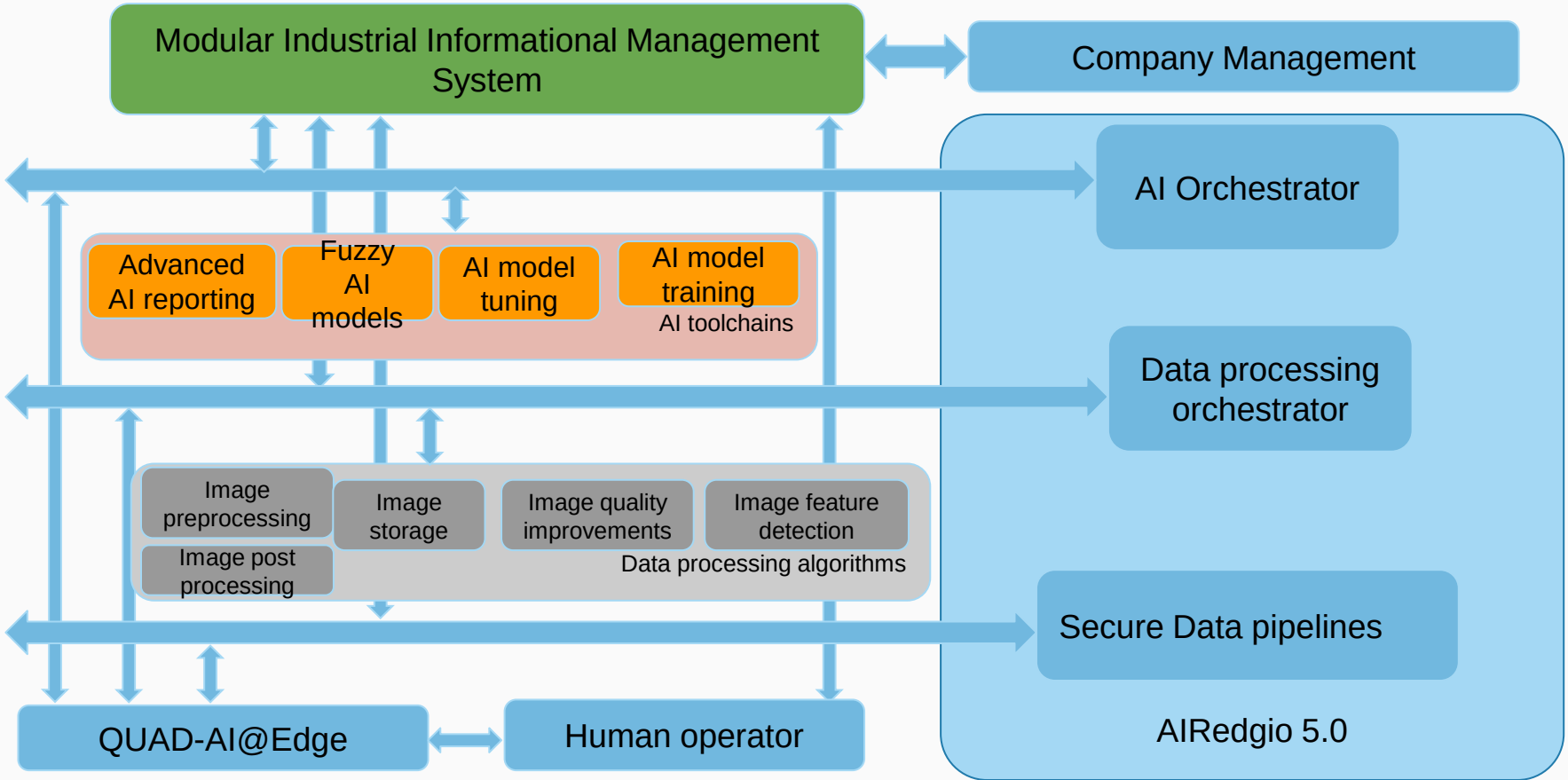
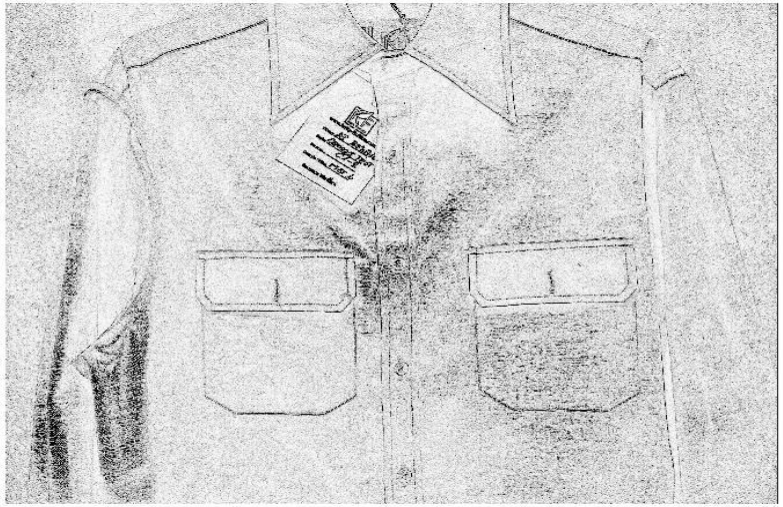
Experiment's Integration with AIRedgio 5.0



Technical solution (software)

Experiment's Implementation status

edge detection **without applying an average filter (LPF)**



Applying an average filter (LPF) followed by edge detection and the cumulation of effects for horizontal and vertical **Sobel** edge detector

for better contoured edges the **Kirsch** operator can be used

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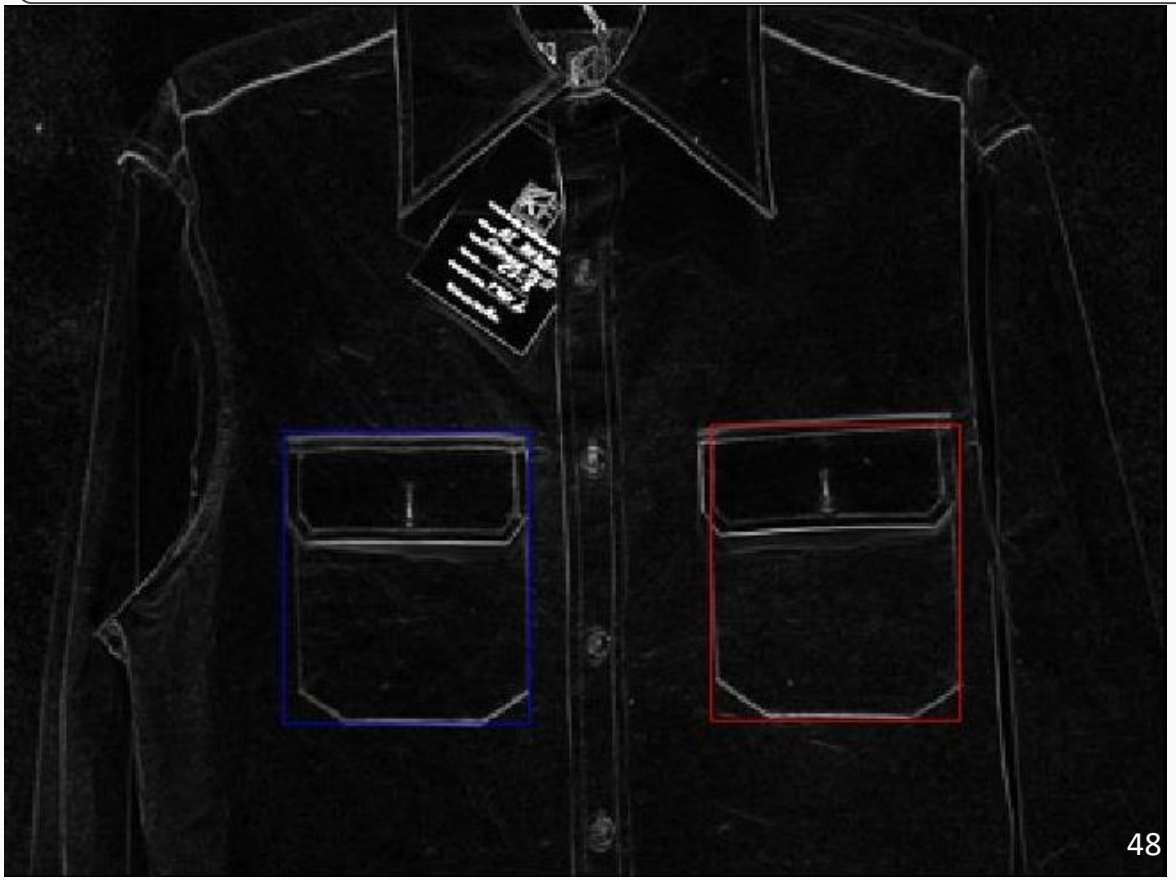
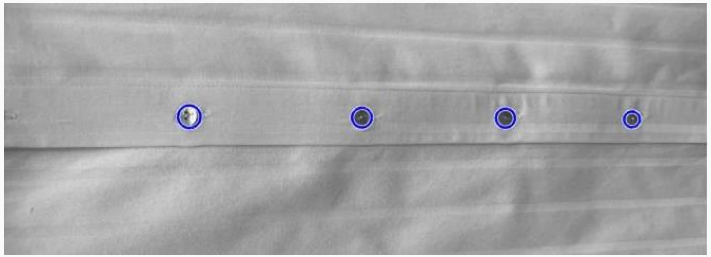
Technical solution (software)

Experiment's Implementation status

Results of the symmetry and position analysis between the two pockets.

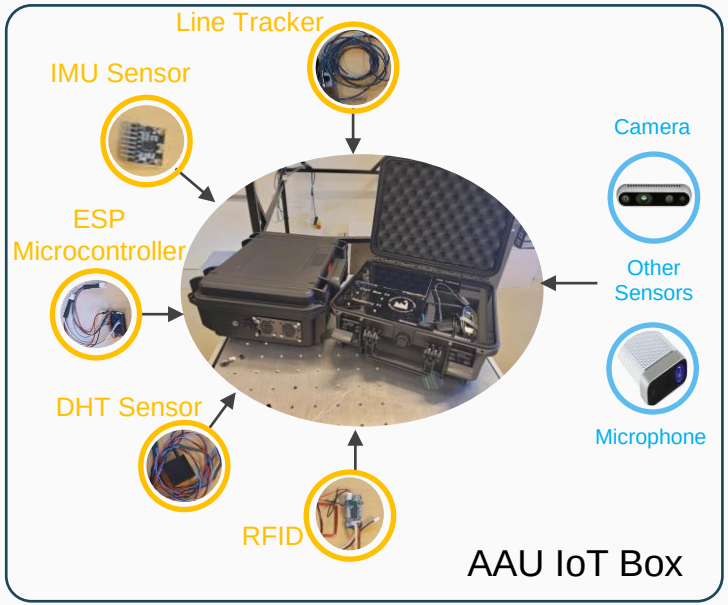


Results of the position analysis for the buttons.



Data-driven IoT Experiment (Smart Lab, Aalborg University)

- **Experiment and Motivation** : focus on using the AAU IoT suitcase with data analytics/machine learning capabilities.
- **Concept:** Integrate IoT suitcase in the shop floor and extract the meaning of data via data analysis methods
- **Challenge:** Data quality, integration, expertise.



Data

Data

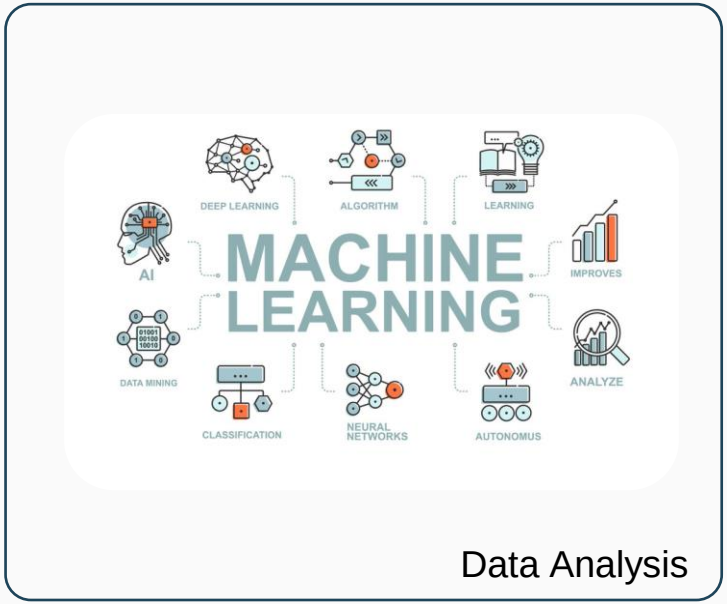


Image src: https://www.fsm.ac.in/blog/an-introduction-to-machine-learning-its-importance-types-and-applications/

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General Description

Experiment

Motivation: Design/Develop/Evaluate ML/DL algorithms for manufacturing tasks

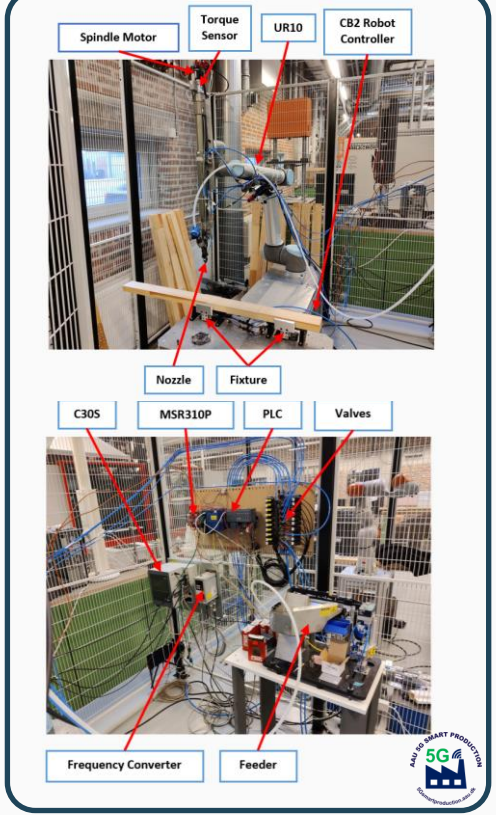
Target: Enhance product quality, Reduce costs

End User: AAU 5G SMART PRODUCTION 5Gsmartproduction.aau.dk — VELUX® (Large corp)

Case: Detect the anomaly of a Robot Screwing process

VELUX®

Velux is a Danish manufacturing company that specialises in roof windows, skylights and related accessories.



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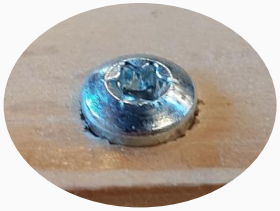
Experiment's Implementation

Screwing Process

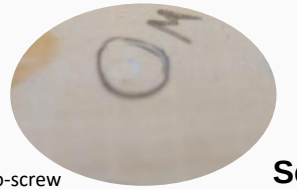
Normal screw



Over-Tightened screw

Under-Tightened screw

Pose anomaly



No-screw

Screw Type

Examples of Anomalies

Under-Tightening

Data Collection Process

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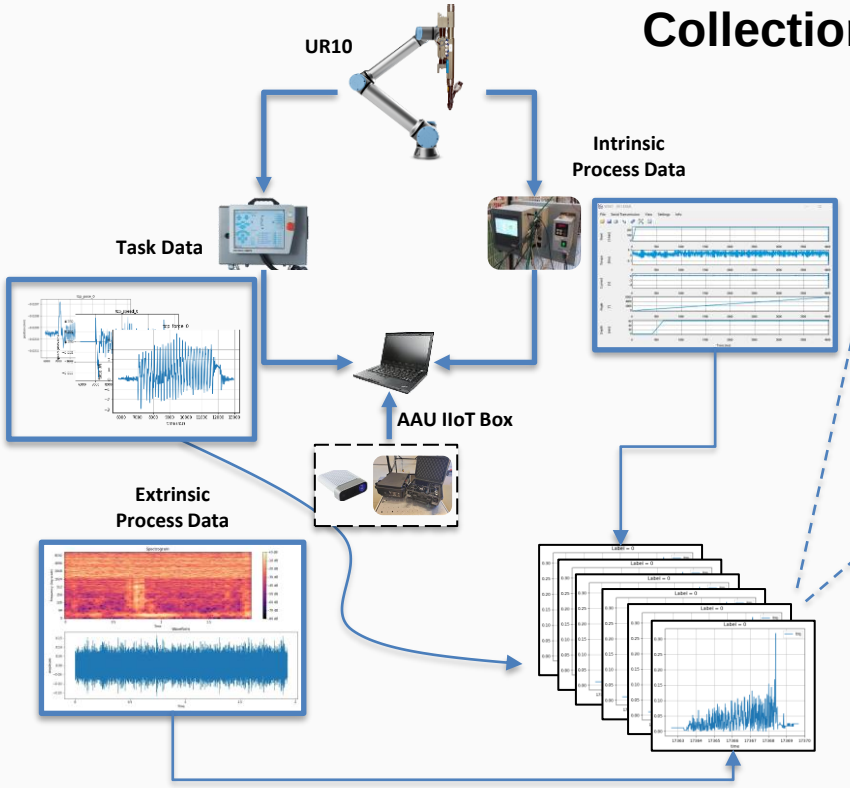
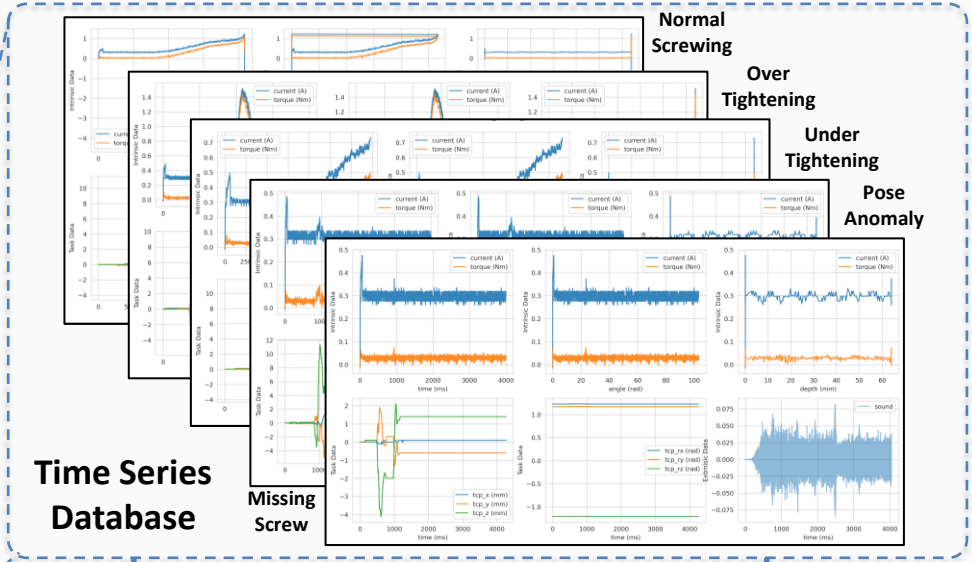
Experiment's Implementation

Data from three different sources are collected:
- **Screwdriver controller** provides **intrinsic process data**
- **Robot controller** provides **task data**
- **Microphones** provide **extrinsic process data**

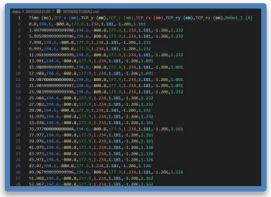
Data Collection



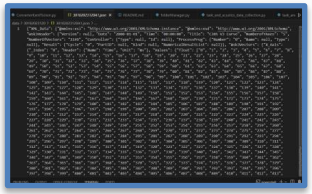


Data format

Task Data (csv file)



Intrinsic Process data (JSON file)



Extrinsic Process data (wav file)

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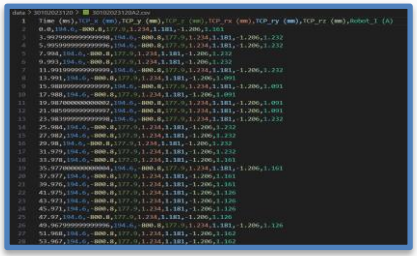
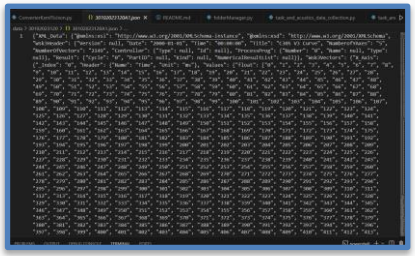
Experiment's Implementation

Feature Extraction

Task Data



Intrinsic Process data



Automatic feature extraction

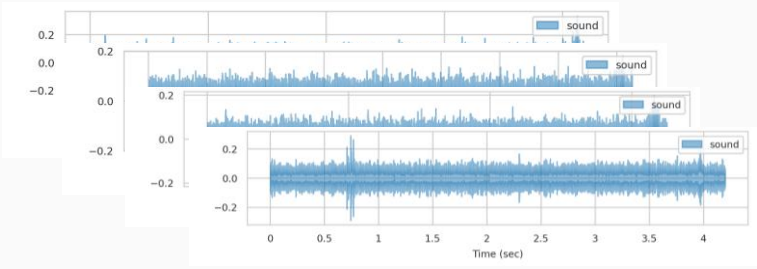
tsfresh

Example

	A	B	C	D	E	F
1		Angle (deg)__sum_values	Angle (deg)__median	Angle (deg)__mean	Angle (deg	Angle (deg
2	id030520234000	2495588.399	1327.2	1328.147099	1879	806.107
3	id030520234001	2158878.933	1231.8667	1232.940567	1751	750.958
4	id030520234002	2345151.866	1285.46667	1286.424502	1823	781.982
5	id030520234003	1558602.266	1041.33337	1042.543322	1495	640.597
6	id030520234004	1867665.333	1143.266665	1144.402777	1632	699.646
7	id030520234005	1804478	1123.06665	1124.285358	1605	688.007
8	id030520234006	1639218.266	1068.733335	1069.985813	1532	656.542
9	id030520234007	1830044.533	1131.266665	1132.4533	1616	692.746
10	id030520234008	1992335.999	1182	1183.097387	1684	722.062
11	id030520234009	1677087.333	1081.46667	1082.690337	1549	663.877
12	id030520234010	2263934.266	1262.333325	1263.356175	1792	768.624
13	id030520234011	1963031.201	1173	1174.061723	1672	716.89

- MinimalFCParameters: (Intrinsic data - 50 features, task data - 70 features)
- EfficientFCParameters: (Intrinsic data - 3885 features, task data - 5439 features)

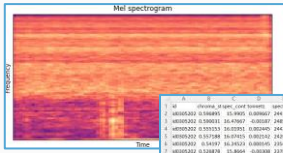
Extrinsic Process data (wav file)



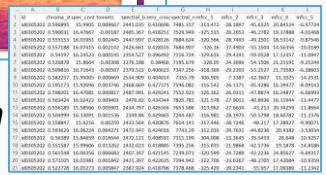
Audio Data Analysis

librosa

Audio Feature Visualization



Audio Feature Extraction



Time Series Data Preprocess

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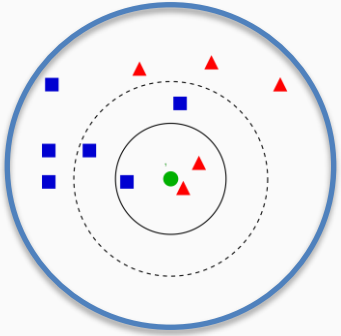
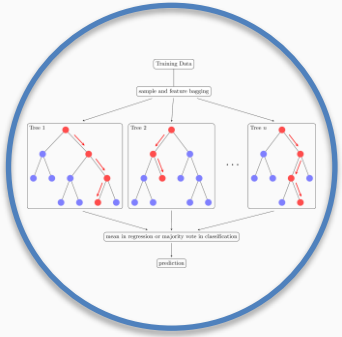
Experiment's Implementation

Model Building



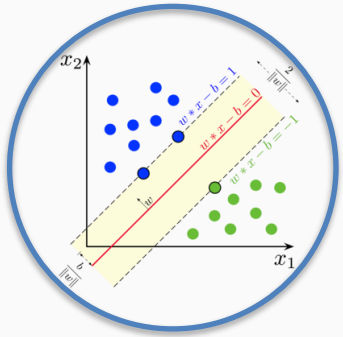
K-Nearest Neighbours (KNN)

```
# Creating the KNN classifier with k=3
knn = KNeighborsClassifier(n_neighbors=3)

# Training the KNN classifier on the training data
knn.fit(X_train, y_train)

# Making predictions on the testing data
y_pred_k = knn.predict(X_test)

# Evaluating the KNN classifier's performance
print(classification_report(y_test, y_pred_k))
# Evaluate the model
print('Accuracy:', accuracy_score(y_test, y_pred_k))
```



Random Forrest (RF)

```
# Define the model
from sklearn.ensemble import RandomForestClassifier
model = RandomForestClassifier(n_estimators=100, random_state=42)

# Split data into training and test sets
X_train_r, X_test_r, y_train_r, y_test_r = train_test_split(X, y, test_size=0.4, random_state=42)

# Train the model
model.fit(X_train_r, y_train_r)

# Make predictions on the test set
y_pred_r = model.predict(X_test_r)

# Evaluate the model
print('Accuracy:', accuracy_score(y_test_r, y_pred_r))


# Evaluate the model's performance
print(classification_report(y_test_r, y_pred_r))
```



Support Vector Machines (SVM)

```
# Create a SVM model with a radial basis function (RBF) kernel
from sklearn import svm
#svm_model = SVC(kernel='rbf')
svm_model = svm.SVC(kernel='rbf', probability=True)
# Fit the model on the training data
svm_model.fit(X_train, y_train)

# Make predictions on the test data
y_pred_s = svm_model.predict(X_test)

# Evaluate the model's performance
print(classification_report(y_test, y_pred_s))
print('Accuracy:', accuracy_score(y_test, y_pred_s))
```

Full source code available at ***https://github.com/lcroy/AAU-IoT-Solution-AI-REDGIO/tree/main/Machine%20learning***

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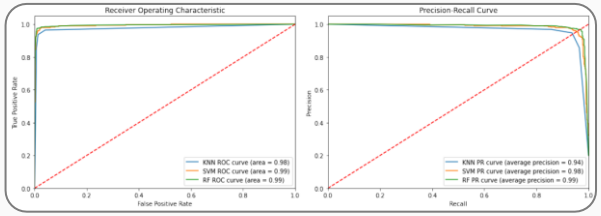
Experiment's Implementation

Results

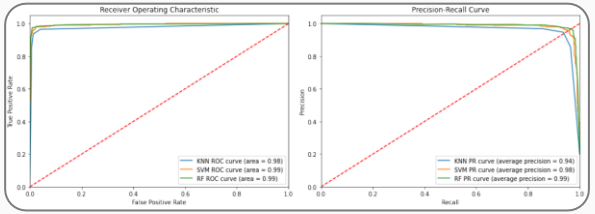
Classification of screw classes with Intrinsic/Task/Extrinsic dataset

	INTRINSIC BASELINE MODEL			TASK BASELINE MODEL			EXTRINSIC BASELINE MODEL		
Algorithm	KNN	SVM	RF	KNN	SVM	RF	KNN	SVM	RF
Accuracy	0.9404	0.9572	0.9683	0.9311	0.9255	0.9479	0.6406	0.7821	0.7803
Precision	0.9423	0.9576	0.9691	0.9321	0.9295	0.948	0.6771	0.8085	0.8026
Recall	0.9404	0.9572	0.9683	0.9311	0.9255	0.9478	0.6406	0.7821	0.7803
F1-Score	0.9404	0.9572	0.9684	0.9313	0.926	0.9479	0.6305	0.7787	0.7759
AUC	0.977	0.9941	0.9945	0.9839	0.9928	0.9937	0.8761	0.9632	0.9535

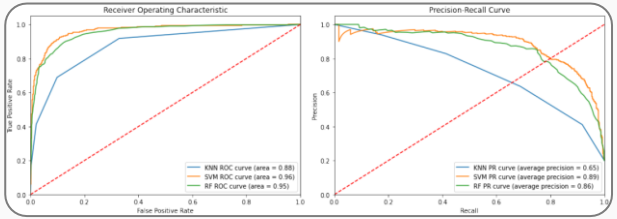
ROC and Precision-Recall graph for intrinsic data



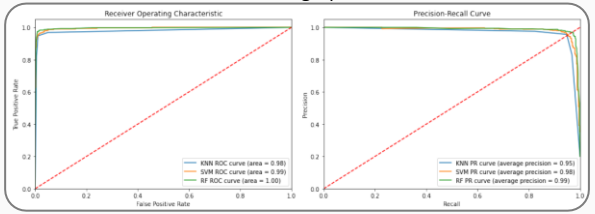
ROC and Precision-Recall graph for task data



ROC and Precision-Recall graph for extrinsic data

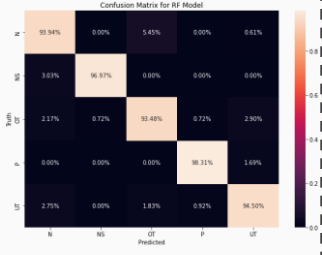


ROC and Precision-Recall graph for combined data

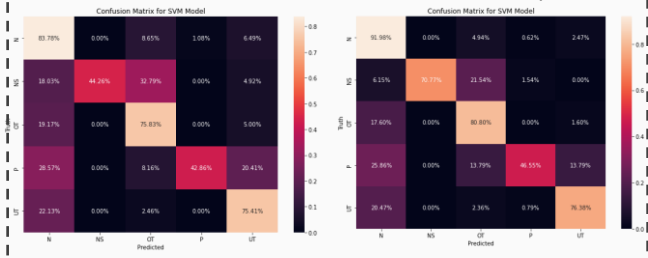


Intrinsic dataset

Task dataset



Extrinsic audio before and after noise reduction)



Confusion Matrix

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Benefits

- **Operational Efficiency Improvement**
  - Real-time monitoring: SMEs can monitor their production in real-time, enabling them to respond quickly to changing conditions and improve decision-making.
  - Predictive maintenance: By analyzing sensor data, SMEs can predict when a device is likely to fail and take preventative measures to avoid downtime and reduce maintenance costs.
- **Product Quality Enhancement**
  - Enhance product quality: Data driven IoT solution can help SMEs to monitor the quality of their products in real-time, identify defects, and take corrective action.
- **Cost Reduction**
  - Reduce costs: Data driven IoT solution can help SMEs to identify areas where costs can be reduced, such as maintenance, and waste reduction.
- **Company Image Enhancement**
  - Enhance company image: By demonstrating a commitment to innovation and technology, SMEs can enhance their reputation and attract new customers.

Q&A

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THANKS

Does anyone have any questions?

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