ENFIELD

CALL FOR PROPOSALS

INNOVATION SCHEMES

CATALOGUE OF CHALLENGES

ENFIELD: EUROPEAN LIGHTHOUSE TO MANIFEST TRUSTWORTHY AND GREEN AI

Co-funded by the European Union

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INTRODUCTION

This is the second out of two open calls, under the ENFIELD[1] (European Lighthouse to Manifest Trustworthy and Green AI) project, co-funded by the European Union, to call for innovation proposals submitted by legal entities. Through the ENFIELD Innovation Scheme open calls and the Financial Support to Third Parties (FSTP) mechanism, the project aims to attract research/industry partners to conduct applied research related to specific scientific/technological challenges within the industrial domains of energy, healthcare, manufacturing, and space, contributing to the creation of ENFIELD network and the adoption of AI technologies to boost overall EU competitiveness.

[1] Grant Agreement nº 101120657, funded by the European Union.

Industrial Domain: **Healthcare**

IDH.1 - Enhanced AI-Powered Remote Patient Monitoring

Keywords: Cardiac events detection, AI-powered wearable, Context-aware monitoring, Embedded algorithms, Physiological data interpretation

STATE-OF-THE-ART

Current wearable health devices primarily rely on photoplethysmography (PPG) for heart rate tracking and basic physiological monitoring, alongside limited single-lead ECG for cardiac rhythm analysis. While effective in some cases, these solutions often lack access to raw sensor data and restrict real-time algorithmic intervention. Future trends point toward multi-sensor platforms integrated with on-device AI capable of early anomaly detection, context-aware data interpretation, and adaptive feedback. Scientific challenges remain in ensuring continuous data quality, minimizing power consumption, and enabling scalable, privacy-compliant data processing. Overcoming these barriers offers opportunities for personalized, preventative healthcare via AI-augmented wearables.

SCIENTIFIC CHALLENGES

Novel device embedded AI algorithms for detecting heart conditions - Cardiac Arrhythmias - particularly atrial fibrillation as well as hypertension, fatigue, and/or glycaemic dysregulation.
Early detection of the relevant vital signs of cardiac events by analysing multimodal data streams in real-time with an AI-powered wearable device. Putting vital signs into the correct context of interpretation by detecting the type of physical activity using information from accelerometer sensors embedded in the device. Use unsupervised pre-training methods to obtain a distilled and fast working on-line activity detection algorithm.
Infrastructure and Data Requirements:
To effectively address this scientific challenge, the necessary infrastructure should include wearable technology or a functional prototype capable of executing the proposed algorithm. The embedded system should support AI model deployment and facilitate simulation of cardiac events on the prototype wearable device. Additionally, efficient and secured data storage solutions are essential to ensure reliability and data protection.
Furthermore, access to relevant data will be viewed favourably for the applicants who can offer it. This may include anonymized or synthetic patient records, or partnerships with medical institutions that provide access to such data for research purposes.

EXPECTED RESULTS

The goals are to:
1) Create and deploy software algorithms on the wearable device with real-time monitoring and embedded AI algorithms that timely detect cardiac events and promptly alert the patient and caregivers.
2)The research is expected to result in at least one functional wearable prototype at TRL 4–5, equipped for contextualized, multi-sensor data collection and future AI model integration.
3) At least 2 conference/journal paper publications.

POSSIBLE OWNER/MENTOR INSTITUTION

Maggioli Group (https://www.maggioli.com)
UPB, Politehnica University of Bucharest (https://aimas.cs.pub.ro/)

Industrial Domain: **Energy**

IDE.1 - Early Signs of Energy Poverty
Keywords: Energy; poverty; social; prediction; efficiency
STATE-OF-THE-ART
Energy poverty occurs when a household must reduce its energy consumption to a degree that negatively impacts the inhabitants' health and wellbeing[2]. EC's Social Welfare and Clean Energy policies still miss an approach from Data Economy's lens. AI techniques are increasingly employed to alleviate Energy Poverty, yet few studies address it as a **multidimensional** issue. Neural Networks prevail in characterizing low-income, energy prices, and poor efficiency. Support Vector Machines excel in energy consumption analysis, while deep learning identifies billing irregularities. **Multidimensional** AI models are expected to boost governments' strategies against Energy Poverty, though GDPR poses significant challenges.
SCIENTIFIC CHALLENGES
Regressive AI models can easily help on the process but, for a wide and fair application, these models need to commit to Green, Human-Centric, and Trustworthy AI, as defined on ENFIELD. Green AI algorithms use is required, to make re-training and possible federation applicable to several entities (Regulators, Utilities, Municipalities, NGOs, etc.) where low processing power is available. Privacy should always be respected, and social bias avoided, or the model will fail its trustworthy targets. Reinforcement learning may be applied locally to the case, so that higher improvement rates can be accomplished while respecting the human-centric approach. An architecture that keeps data in its original place, without replication is preferred. Supplied data includes social building aggregated data regarding energy consumption anonymized and geographical location. Any other data, needed for the model, may be externally acquired but free of charge, avoiding any external dependence when scaling-up and replicating the model.
EXPECTED RESULTS
In first month of works, attainability of the following results or any anticipated limitations, should be reported. Models to predict if and when consumers will enter Energy Poverty, including uncertainty estimation are expected. The model(s) should run locally on the end-user's machine and be accessible via a web interface, inputting 'CSV' or 'xlsx' data files and outputting a vector with predictions: timing, and uncertainty. Additional helpful output data will be well remarked. The end-user will generate test cases to verify the model's effectiveness, and KPIs will be defined jointly between EDP CNET and the awarded organization. The model may be replicated to other geographies using acquired or third-party free/open data without compromising EDP Group. EDP CNET and end-users may use the model and user interface for their organizations' purposes and share it to aid government decisions, naming at all times the awarded organization as author in the context of ENFIELD.
POSSIBLE OWNER/MENTOR INSTITUTION
EDP CNET (https://www.edp.com/en/innovation/NEW)

[2] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-poverty_en

Industrial Domain: **Energy**

IDE.2 - City Sustainability Index
Keywords: Industrialisation, Energy Requirements, AI Dashboards, City Sustainability, Internet of Things (IoT)
STATE-OF-THE-ART
Industrialisation necessitates a correlated development of public infrastructure by the public entities, and increased energy requirements. This includes, but is not limited to, the construction of new roadways to facilitate daily commutes, residential housing to accommodate population influx, educational and other public amenities to support families and community expansion within the industrial area. Furthermore, computation of the city's sustainability index, energy demands, and other environmental analytics services are the need of the hour. And, additional data ingestion can be facilitated through IoT data streams originating from diverse internal Maggioli Smartcity IoT platforms.
SCIENTIFIC CHALLENGES
Model the mapping of an area as proof-of-concepts in the form of an AI-based energy consumption dashboard - of a smart city as an aggregator of multiple sources of operational data, pollution indexes and energy usages. Consider the industrial and residential environment as a living laboratory, including running analytics services based on the multitude of data inputs of the city. Predict the influx of people migrating to a newly developed industrial area within a city. Creation of software algorithms as a method to calculate additional energy usages due to the population growth and increment of public infrastructure requirements in the proposed industrial zones.
EXPECTED RESULTS
The goals are: 1) Correlation analysis between heterogeneous operational data; 2) Creation of non-linear and time-based impact indices; 3) Creation of software algorithms to formulate and track energy demand prediction 4) Creation of an AI based energy dashboard as a method of output visualisation 5) At least 2 conference/journal paper publications. The expected outcomes are to develop AI/ML based algorithms and methods to achieve a more granular understanding of the energy usage and publish research papers.
POSSIBLE OWNER/MENTOR INSTITUTION
Maggioli Group (https://www.maggioli.com)

Industrial Domain: Manufacturing

IDM.1 - Enhancing robotic disassembly of electronics and household appliances with adaptive AI

Keywords: Adaptive AI, robotic disassembly, screw detection, repair and remanufacturing, electronics and household appliances.

STATE-OF-THE-ART

Repairing and remanufacturing electronics and household appliances are well-known strategies to promote circularity. These processes can be enhanced through automation using robot- and AI-driven solutions for disassembling the products.
A key challenge in implementing such solutions is the vast diversity of product designs, even within a single product category like laptops or refrigerators. These AI-driven solutions lack indeed the ability to automatically adapt their behaviour when faced with products, whose designs are different from the ones used to create the initial training dataset. Adaptive AI methods could be investigated and implemented to support this adaptation.

SCIENTIFIC CHALLENGES

The scientific challenge involves developing adaptive AI methods to detect in real time screws in 2D images and/or 3D point clouds, enabling a robot arm equipped with a screwdriver to remove them. The focus will be on two product categories — laptops and refrigerators — and the methods must accommodate varying product designs, implying differences in screw sizes, colours, and shapes within each product category. Additionally, the methods should demonstrate the capability to handle new or unknown product designs without requiring a complete retraining of the AI model used for screw detection. Approaches involving Interactions with an operator during the disassembly operation (manual guidance, voice commands, interaction with the system through dedicated GUI, etc.) can be considered.
To address the challenge, applicants should be able to work on operational systems to detect screws in 2D images and/or 3D point clouds, enabling a robot arm equipped with a screwdriver to remove them. Such systems could eventually be made available and used as test demonstrators at the mentor institution. While limited datasets with real data can be provided, applicants are expected to supply additional data to test adaptive AI methods if needed and necessary.

EXPECTED RESULTS

A novel adaptive AI method should be developed to train an AI model able to detect in real time laptop or refrigerator screws from 2D images and/or 3D point clouds, and adapt its behaviour when faced with products, which designs are different from the ones used to create the initial training dataset. The developed method may combine some interactions between the operator and the robot solution. This method should be demonstrated thanks to a proper setup with a robot arm equipped with a screwdriver. The mentor institution may require testing the developed method in its facilities.
The research is expected to result in at least one peer-reviewed scientific publication. Datasets and code used and developed during the project are encouraged to be made available to the general public.

POSSIBLE OWNER/MENTOR INSTITUTION

DTI – Danish Technological Institute (https://www.dti.dk/)
Politecnico di Milano (https://www.som.polimi.it/)
Predict – iQANTO (https://www.snef.fr/iqanto/en/)

Industrial Domain: Manufacturing

IDM.2 - Metrics and tools for assessing dataset reliability and robustness in Smart Manufacturing

Keywords: Dataset reliability, dataset robustness, smart manufacturing, software tools and metrics, AI safety

STATE-OF-THE-ART

Smart factories depend extensively on AI-driven data analysis, which involves the generation of vast datasets that may include augmented, synthetic, and AI-generated data. While this is essential and advantageous, it also raises critical concerns about the safety and trustworthiness of AI systems trained on such datasets, particularly in terms of their reliability and robustness.

Although frameworks for assessing AI safety risks do exist, they are largely theoretical and do not specifically address the processes involved in dataset creation. Manufacturing companies require specialized software tools and metrics to effectively evaluate the robustness and reliability of their datasets.

SCIENTIFIC CHALLENGES

The scientific challenge lies in determining the reliability and robustness of AI models used in smart manufacturing, based on their training datasets. These datasets may combine real data with augmented, synthetic, or AI-generated data. Software tools and metrics for assessing the robustness and reliability of these datasets must be practical and user-friendly for implementation in manufacturing settings.

AI-driven manufacturing scenarios will be suggested by the mentor institution, but suggestions from applicants will be welcomed. Applicants are responsible for creating their own datasets, based on either time series or 2D images, as well as developing and using their own methods to enhance these datasets with augmented, synthetic, or AI-generated data.

EXPECTED RESULTS

The primary goal of this challenge is to create software tools and metrics to assess the robustness and reliability of a dataset — including augmented, synthetic, and AI-generated data — and potentially consider the AI model trained on it.

The tools and metrics should implement measures to assess risks such as (but not limited to) bias, exposure of sensitive information, operator safety, system integrity, and disruptions to operational workflows.

The research is expected to result in at least one peer-reviewed scientific publication.

Datasets and code used and developed during the project are encouraged to be made available to the general public.

POSSIBLE OWNER/MENTOR INSTITUTION

DTI – Danish Technological Institute (https://www.dti.dk/)
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IDM.3 - Computer Vision for feet recognition

Keywords: Computer Vision; lower limb; feet gesture; gesture recognition; Human-Machine Interaction.

STATE-OF-THE-ART

No existing pre-trained model specifically focuses on recognising feet or shoes of human operators. Current models and libraries target hand or full-body recognition[3], providing 2D joint key-points relevant to posture. However, these tools are unsuitable for industrial scenarios due to limited foot-related key-points and required perspectives. Healthcare models do recognise feet using Computer Vision, but these are designed for specific purposes, such as walking posture estimation[4] or recognising naked-foot joints in podiatry[5], making them inadequate for industrial applications, where shoes or footwear are typically involved.

SCIENTIFIC CHALLENGES

Current Computer Vision tools for Human-Machine Interaction focus on hand-gesture recognition, using pre-trained pipelines for specific tasks. Despite their promising results, these tools suffer from an intrinsic drawback, which lies in the fact that in production or assembly lines operators need both of their hands to perform the manual tasks they were assigned. A feet-recognition model, especially for shoes, could replicate hand-based tools' functionalities, freeing operators from pausing their work to interact with machines, thus enhancing ergonomics and overall workplace wellbeing. Such technology could be beneficial for manual, logistics, and warehouse operators by allowing them to instruct Autonomous Mobile Robots, machines and collaborative robots, while improving safety perception and productivity.

EXPECTED RESULTS

Starting from a real-like setting (working table mounted at height of 0.9m with a camera oriented toward the floor, or subjective camera of an AMR) the proposed model is supposed to efficiently classify a series of feet gestures, interfacing them with the assets involved in the collaboration (e.g., AMR, collaborative robot).
Impact for this kind of application is supposed to materialise in a success story able to introduce this solution into the manufacturing environment, paving the way towards industrial solutions able to be exploited in real industrial plants. It is also deemed beneficial for the operators with upper limbs deficits, who would be then able to spread their employability in workplaces embodying advanced human-machine interfaces.
The research is expected to result in at least one peer-reviewed scientific publication.
Please notice the host won't provide any training dataset.

POSSIBLE OWNER/MENTOR INSTITUTION

Politecnico di Milano (https://www.som.polimi.it/)
Predict – iQANTO (https://www.snef.fr/iqanto/en/)
DTI – Danish Technological Institute (https://www.dti.dk/)

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[5] F. Kok, J. Charles, and R. Cipolla, 'FootNet: An Efficient Convolutional Network for Multiview 3D Foot Reconstruction', in Computer Vision – ACCV 2020, vol. 12627, H. Ishikawa, C.-L. Liu, T. Pajdla, and J. Shi, Eds., in Lecture Notes in Computer Science, vol. 12627. , Cham: Springer International Publishing, 2021, pp. 36–51. doi: 10.1007/978-3-030-69544-6_3

IDM.4 - Transitioning to Industry 5.0 by enhancing worker safety and well-being in the manufacturing industry

Keywords: Industry 5.0, Trustworthy and human-centric AI, working environment, robots/cobot

STATE-OF-THE-ART

The manufacturing industry initiated its transition to digitalization, with production plants starting to collect data in line with the Industry 4.0 trend. However, the integration of digital transformation with sustainability challenges remains limited. Current advancements primarily focus on monitoring individual manufacturing process indicators to enhance productivity, without considering other essential dimensions such as improving workers conditions or optimizing resource consumption to reduce environmental impact throughout the product lifecycle. The use of artificial intelligence (AI) technologies, in particular human-centric and trustworthy AI techniques as well as natural language processing (NLP), opens new opportunities to enhance worker well-being, placing them at the center of the production process. By leveraging these new technologies, industries can play an active role in addressing societal challenges, including resource preservation, climate change, and social stability. This also could enable employees to focus on more valuable and creative tasks, working alongside AI in what is known as "hybrid intelligence" to ensure prosperity beyond employment and economic growth while respecting the planet's production limits.

SCIENTIFIC CHALLENGES

This use case aims to tackle the challenges to move toward the Industry 5.0 concept, focusing on the well-being of operators. Employees tend to experience lower levels of stress and higher levels of well-being when working in units that have a positive organizational climate characterized by safety, fairness, interpersonal treatment, control, support, and efficiency. Human-centric and trustworthy AI techniques need to be integrated into AI-powered robots that are increasingly taking on monotonous and physically demanding tasks. The main objectives for this challenge would be: **Reduction of operational risks:** Manufacturing requires high accuracy and reliability, and current models can lack the precision needed in some sensitive production environments. These techniques must be enhanced to consider the overall environmental conditions and the fundamental health status of employees, helping to minimize operational risks and reducing the risk of workplace injuries. **Ensuring fairness and equity:** The working environment in the manufacturing industry remains predominantly male, which should be addressed in future AI systems to ensure that robots and cobots are not influenced by or embed gender biases when working alongside operators. **Addressing the change management:** Most of the organizations deemed at least some level of impact from AI and automation. However, integrating these technologies can meet resistance from employees concerned about the reliability of these systems and questioning their fairness and transparency. Trustworthy AI approaches should be prioritized and properly introduced to workers to enable them to adopt and integrate these technologies.

EXPECTED RESULTS

A Human-centric and/or trustworthy IA solution that is capable of processing and analyzing data from various sensors and production lines to detect anomalies or malfunctions that could endanger employees including the estimating of worker's stress, well-being, and degree of depression using vital data collected from sensing devices but also ensuring transparent communication, clear policies on data usage, and measures to protect worker privacy. Additionally, this AI system should tackle biases and guarantee gender equity in their recommendations as it's crucial for their effectiveness and acceptance.

POSSIBLE OWNER/MENTOR INSTITUTION

Predict – iQANTO (https://www.snef.fr/iqanto/en/); Politecnico di Milano (https://www.som.polimi.it/); DTI – Danish Technological Institute (https://www.dti.dk/)

Industrial Domain: Space

IDS.1 - Space-based maritime surveillance
Keywords: Artificial Intelligence; Earth Observation; Maritime; Remote Sensing
STATE-OF-THE-ART
Currently, industry Remote Sensing (RS) and Earth Observation (EO) plays a strong role in the surveillance of marine and maritime fields. Object-detection, segmentation, and classification models are widely used to infer on images derived from space-based instruments. The main purpose is the detection and monitoring of illegal fishing activities, oil spills, algal bloom events, and sea pollution among others.
SCIENTIFIC CHALLENGES
Several scientific challenges persist in leveraging EO and AI for maritime surveillance. The main challenges that have to be faced are the dynamic character (e.g., vessels on movement, oil spill development, etc) of the events in the sea, the variability of sea conditions, the integration of processing data from multiple EO sources and to ensure rapid response capabilities by the incorporation of multiple EO sources, while at the same time the number of false alarms is minimized. The main object of this ENFIELD scientific challenge is the application of an AI and EO based approach for the development of a proof-of-concept application for the continuous monitoring and the triggering of alerts for threats (e.g., illegal fishing, pollution, oil spills, etc.) in the Exclusive Economic Zone of Cyprus (Mediterranean Sea)
EXPECTED RESULTS
This use case aims to investigate innovative AI-based approaches and the development of a proof-of-concept application for the continuous monitoring of the maritime sector using Earth Observation data. From this industrial and scientific challenge, the following are expected: 1. A publication at a high-impact factor journal. 2. AI Algorithms/models. 3. A proof-of-concept application.
POSSIBLE OWNER/MENTOR INSTITUTION
ERATOSTHENES Centre of Excellence – EcoE (https://www.eratosthenes.org.cy/)

Industrial Domain: **Space**

IDS.2 - Robust vision-based autonomous navigation for low SWaP UAVs
Keywords: Artificial Intelligence; Vision-Based Navigation; UAV; Low Size, Weight and Power; Autonomy
STATE-OF-THE-ART
Visual localization and mapping, obstacle avoidance, and path planning are essential components of vision-based navigation systems. Traditionally, several non-AI techniques are employed to perform simultaneous localization and mapping (SLAM), Visual Odometry (VO) and both relative and global positioning. Geometric feature extraction and matching algorithms facilitate the acquisition of reference points, while final localization is determined through the integration of multiple data sources, such as Global Navigation Satellite Systems (GNSS) and Inertial Measurement Units (IMU). Furthermore, any robust and comprehensive navigation solution must incorporate effective obstacle avoidance and path planning techniques.
SCIENTIFIC CHALLENGES
The use of AI techniques within the framework described presents several challenges that, although not exclusive to the domain of vision-based navigation, are of great relevance to it. Tasks such as feature extraction using deep learning, image registration, pattern matching, and obstacle avoidance are suitable candidates for AI applications. Moreover, the dynamic environments in which small and medium-sized Unmanned Aerial Vehicles (UAVs) operate are constantly evolving. Consequently, the algorithms must be capable of adapting to these changes in real-time. Additionally, since any AI solution must operate onboard and autonomously, small and medium-sized UAVs face significant constraints regarding power consumption. Therefore, navigation algorithm candidates must be designed to run on energy-efficient embedded computing solutions with a limited power budget. Finally, given that navigation, obstacle avoidance, and path planning are critical functions, any AI algorithms considered must demonstrate a high level of robustness and trustworthiness. The main objective of this ENFIELD scientific challenge is to apply an AI-based approach to one or more of the challenges associated with image-based navigation, while emphasizing algorithm reliability, robustness, and low power demands.
EXPECTED RESULTS
This use case aims to explore innovative AI-based methodologies and develop a proof-of-concept application for robust vision-based navigation algorithms utilizing AI. From this industrial and scientific challenge, the following outcomes are anticipated: 1. Development of AI algorithms/models. 2. A proof-of-concept application. 1. One publication in a high-impact factor journal.
POSSIBLE OWNER/MENTOR INSTITUTION
Boeing Aerospace Spain – BAS (https://www.boeing.com)