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Project Results

PIANiSM

Boosting predictive maintenance across manufacturing

The ITEA project PIANiSM (Predictive and Prescriptive Automation in Smart Manufacturing) has used a common architecture to create diverse solutions for predictive maintenance (PdM), allowing for easier integration and greater scalability than was previously possible.

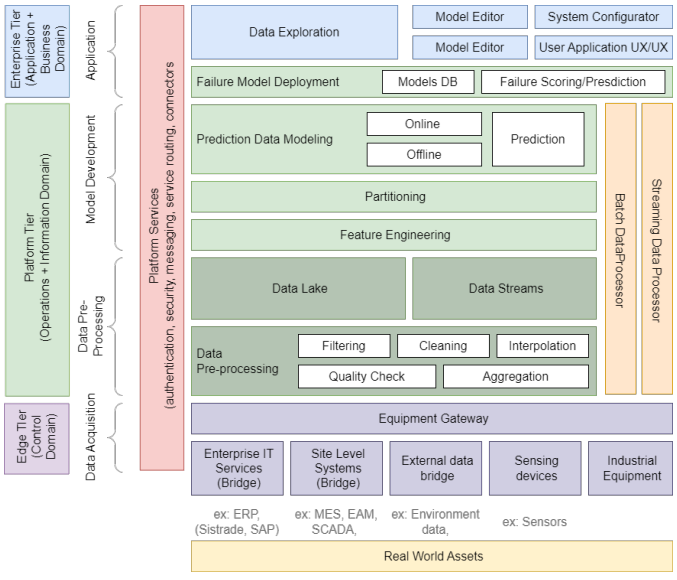
Project origins

PdM offers benefits across many fields, from manufacturing to mining to automotive. By predicting issues before they occur, companies avoid wasting time and money on repairs and downtime, allowing them to be more efficient throughout their operations. However, most PdM solutions are domain or problem-specific, with implementation costs and complexity serving as obstacles to uptake. To disrupt traditional maintenance processes, domains such as data science, machine learning, analytics, simulation and real-time processing must be combined in one system.

The PIANiSM project has aimed to combine predictive and prescriptive maintenance techniques to achieve an end-to-end automated manufacturing process and optimise end-to-end manufacturing value chains. In doing so, it has identified and introduced missing analytics techniques and algorithms and introduced a new generation of data identification integration and modelling processes. An architecture has been created with which partners in Portugal, Spain and Turkey have developed their own products and services across a multitude of use-cases, demonstrating the wide applicability of PdM in many domains.

Technology applied

The PIANiSM architecture comprises four layers for data acquisition, data pre-processing, model development and applications. In the data acquisition layer, an equipment gateway gathers data from external sources such as industrial or sensing devices and stores this in a data lake or online stream. Filtering, cleaning, quality checks, interpolation and aggregation occur in the data pre-processing layer, resulting in an organised data lake or stream. In the model development layer, feature engineering, partitioning, prediction data modelling and failure model deployment take place using techniques such as loss estimation, change detection and failure scoring/prediction. Here, different models have been developed for the needs of different use-cases and are stored in a model database. Finally, the application layer allows for data exploration and contains a model editor, system configurator, data analytics application programming interface and the connection to user applications.



PIANiSM architecture

Using this architecture, PIANiSM's technical partners – KoçSistem, ERSTE, ISEP, Experis, Sistrade and Nimbeo – have each developed separate solutions for exploitation. KoçSistem, for instance, has supplemented its existing big data platform, Platform 360, with a PdM module that uses techniques such as data mining and model management to produce PdM reports, failure prediction and maintenance plans. This can be integrated into customer environments in a scalable and extensible manner. Likewise, ERSTE has created a PdM module which uses machine learning models for anomaly detection, remaining useful lifetime detection and failure probability, allowing parties to create their own tailored PdM models. Overall, PIANiSM has produced use-cases on ceramics, automotive, energy/refineries, durable consumer goods, piping, plastic film/flexible packaging and data networks and has successfully demonstrated its system prototypes in an operational environment (TRL 7).

Making the difference

Thanks in part to the project's wide scope, PIANiSM has been able to expand and improve on PdM services in a variety of ways. In terms of improvements to PdM, PIANiSM has worked with a world-leading automotive client on better prediction and has achieved an 80% success rate (versus a starting point of zero). These types of improvements have a knock-on effect for the efficiency of end-users: refinery operator Tüpraş, for example, has applied KoçSistem's technical outputs to its heater charge pumps, resulting in a decrease in mean time to repair by 3.59 days and a decrease in maintenance costs by USD 5134 per failure. For companies that take up PIANiSM's results, the benefits are focused not only on the cost savings of decreased downtime and fewer repairs but also on the competitive advantage of faster turnarounds and the opportunity to open up new business models through the greater reliability that PdM offers. The latter is particularly significant for SMEs, which have traditionally been confined to reactive maintenance because of the former costs and difficulty of integrating PdM solutions.

PIANiSM partners are now in the process of offering these solutions to new and existing clients but have already shown early promise, such as KoçSistem's signing of a contract with the major automotive client to extend their machines worldwide. Over the next five years, the consortium anticipates a strong sales increase through the introduction of PIANiSM-related technologies (including roughly 100% sales growth for companies in manufacturing and 80% for IT and software), as well as a more than doubling of the international market share in some sectors. In order to achieve these forecasts, strong dissemination has also taken place, including a paper on the project's architecture that was presented at the IEEE Industrial Electronics Society annual conference (IECON 2021) and customer workshops for both Platform 360 and the PdM module. Additionally, PIANiSM resulted in two PhD theses, one master's theses and course material for the ISEP engineering research institute. Having successfully identified new needs in model development, such as auto-encoder neural networks for anomaly detection, the partners will use these results as a springboard to further improve PdM and expand it to new domains in both the short and long term.

Major project outcomes

Dissemination

- More than 6 scientific and non-scientific publications, e.g.: IECON 2022 of IEEE, PAAMS 2022, WorldCIST 2021, WorldCIST 2022, DCAI 2022, Applied Intelligence and Medium
- Several presentation/demos at conferences/fairs, e.g.: EICON 2021 of IEEE, DCAI 2021, High Security Printing EMEA 2020 conf., WorldCis 2021 and WorldCis 2022, Sistrade S-Day 2021 and 2022
- Master and Doctoral Theses (2 PhD and 1 Master theses)

Exploitation (so far)

New products and frameworks:

- 5 different systems and frameworks have been exploited from the project. All of the technical partners created their own system with the same standardised architecture:
  - ECMON platform (Sistrade): provides equipment condition monitoring and prediction for manufacturing environments
  - Platform 360 IoT (KoçSistem): has the ability to have PdM module with the AI/ML models and the ability to manage the models on the system itself
  - PdM Module (ERSTE): robust failure and anomaly detection to prevent failures and unplanned downtime in multi-industry domains
  - Deep Learning-based PdM platform for Industry 4.0 (Nimbeo)
  - PdM product for network anomalies (Experis)

Standardisation

- Standardised architecture for the technical partners which has been also demonstrated on the congress

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PIANiSM

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Partners

Canada

- B3 Systems Inc.

Portugal

- Instituto Superior de Engenharia do Porto (ISEP)
- SISTRADE Software Consulting, S.A.
- Vizelpas - comércio de artigos plásticos LDA

Spain

- Experis ManpowerGroup, S.L.U.
- Nimbeo

Türkiye

- Cimtas Pipe Fab and Trading Ltd. Co.
- Eczacıbaşı Yapı Gereçleri A.S.
- ERSTE Software Limited
- KoçSistem
- ORAU Orhan Automotive
- Tupras-Turkish Petroleum Refineries
- Turk Traktor ve Ziraat Makineleri A.S.
- Vestel

Project start

November 2018

Project end

June 2022

Project leader

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