DayTiMe

Digital twins to enhance predictive maintenance

Success story

Modern life increasingly depends on complex technical systems that are expected to operate reliably and continuously. When such systems fail unexpectedly, the consequences can be significant, ranging from service disruptions and operational delays to increased costs and safety risks. As systems grow more interconnected and technologically sophisticated, even minor faults can propagate quickly and have wide-ranging impacts. In this context, traditional maintenance approaches, which consist of either reacting after a breakdown has occurred or performing interventions at fixed intervals, are increasingly inadequate in the face of rising complexity, cost pressures and expectations of uninterrupted service.

Predictive maintenance provides a more intelligent and forward-looking approach to asset management. By analysing data generated during normal operation, such as sensor measurements, system logs and performance indicators, it becomes possible to identify early signs of degradation and to anticipate failures before they disrupt operations. This leads to tangible benefits, including reduced downtime, lower maintenance costs, more efficient use of resources and safer working conditions.

However, when predictive maintenance is combined with Internet of Things technologies, two significant challenges arise. First, industrial environments often lack sufficient high-quality, labelled data to train and validate predictive models. Second, there is a need to translate complex analytical outputs into actionable maintenance decisions that operators can trust and apply. Digital twins address these challenges by transforming large volumes of raw sensor data into real-time, contextualised representations of physical assets, enabling more reliable predictions and more effective maintenance planning.

Digital twins for manufacturing, healthcare and telecoms

The ITEA project DayTiMe, that ran from September 2018 to March 2022 and brought together 18 partners from Belgium, the Netherlands, Türkiye and the United Kingdom, extended the application of digital twins beyond their traditional association with manufacturing, demonstrating their value in domains such as healthcare and telecoms. By combining artificial intelligence, big data analytics and machine learning, the project explored how predictive maintenance can be supported in diverse operational contexts. The work began with the

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Project start
September 2018

Project end
March 2022

Project leader
Ad de Beer
Philips

More information
https://itea4.org/project/daytime.html

definition of five representative use cases: MRI scanners, shavers, medical supply systems, fault detection in industrial data, and GSM base stations.

Through the analysis of these use cases, shared requirements and recurring design patterns were identified and consolidated into a generic reference architecture for predictive maintenance based on digital twins. This architecture enables third parties to access the generic software through APIs, allowing them to deploy their own applications and develop tailored business insights, smart maintenance solutions, and customer-facing services.

In parallel with the architectural work, DayTiMe delivered a range of innovations within individual use cases. In the context of shavers, digital twinning enables the personalisation of pressure and skin–blade distance, with this information communicated directly to users via a dedicated application. For GSM base stations, a closed feedback loop was implemented, while for MRI scanners the project developed advanced methods for knowledge extraction from written text, anomaly detection in large, unstructured log files without requiring prior domain expertise, and anomaly detection in sensor data affected by utilisation patterns and device interference. Finally, work on fault detection in industrial data led to improved AI-based methods for identifying anomalies in complex time-series data, the automatic identification of time delays and relationships between signals, and the integration of these improvements into the Yanomaly application for machine data analysis, including enhanced user interface features.

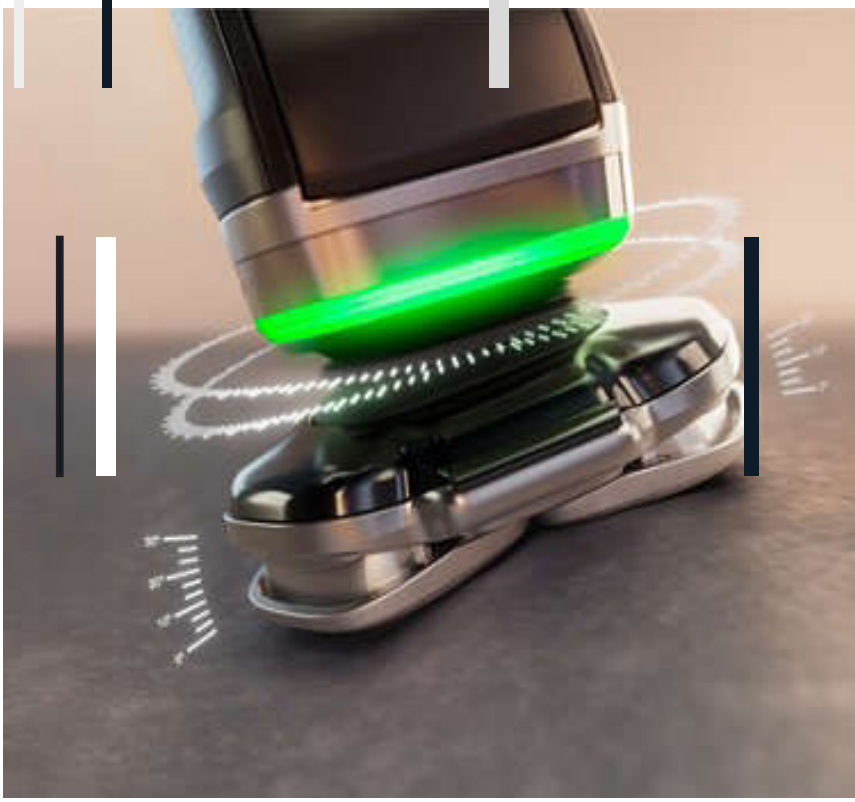
Predictive maintenance breakthroughs driving growth

DayTiMe's predictive maintenance methods have demonstrated strong performance, achieving an equally weighted accuracy of 90% in the detection of critical situations relevant to failure prevention. In addition, an accuracy of 98% was achieved in supporting efficient decision-making, reflecting a high level of statistical

confidence when analysing sample data to derive maintenance needs. Thanks to this foundation, the partners expect DayTiMe's results to be commercialised within one to two years of the project's completion. Additionally, most partners expect to make their return on investment within two to three years.

For example, Dutch SME partner Datenna developed the prototype Multi Agent Reinforcement Tool (MART) to process user feedback. While this prototype was specifically created for the Philips use case, the project had a broader impact on the company. Working on multi-agent AI systems at a time when the field was still emerging gave Datenna a significant head start, and the feedback loops with Philips and other partners helped refine their thinking on AI architectures and applications. The project's digital twin concept (building digital representations of MRI scanners, for example) also influenced how Datenna approached its own platform. This perspective ultimately led them to build what is effectively a digital twin of China's techno-economic landscape, which is now at the core of their OSINT platform for government and intelligence clients. Since the project's start, Datenna has grown from three employees to more than 50, with offices in the Netherlands and the United States and customers in over ten countries. While the path from the project to today has not been linear, it proved to be a meaningful accelerator for Datenna's AI capabilities and product vision.

In addition, the Turkish SME TAZI AI/ Triatech created an AutoML tool to detect lock failure of medicine cabinets a day before the error occurs. Thanks to exploitation of these project's results, TAZI had a very good understanding of the importance of data privacy and integration requirements in healthcare. This led TAZI to further develop its ability to integrate easily with different data and platforms. It also moved TAZI further in its ability to process data where it needs to be processed. Both of these results enabled TAZI to be awarded an honourable mention in Gartner Magic Quadrant for CAIDS (Cloud AI Developer Services) in 2022 as well as to be recognised as a compliant vendor among financial services customers.



Based on the research performed in DayTiMe Philips Medical Systems deployed two new tool updates for their remote service engineers: Predictive Service Portal and Remote Service Portal. Pattern recognition in logfiles has been successfully used in analysing and solving issues in real-life systems. The methods applied to log anomaly and sensor anomaly detection will be reused for other data sets in the near future.

The University of Groningen developed advanced Micro Electro-Mechanical Systems (MEMS) pressure sensors, which were successfully integrated into Philips shavers. Building on this technology, Philips Consumer Lifestyle introduced new levels of personalisation by optimising shaving pressure and adjusting the distance between skin and cutter for improved comfort and performance. Users receive real-time feedback through an intuitive light ring on the device, as well as via a dedicated app that has been continuously enhanced over time. This combination of smart sensing, user guidance and ongoing software improvements has resulted in a more personalised and effective shaving experience.

For PS-Tech, the development of the AR maintenance tool not only delivered a cutting-edge solution but also established a robust knowledge foundation of AR algorithms. This expertise is now actively applied in ongoing developments regarding the creation of solutions combining PS-tech's optical tracking systems with head-mounted displays. Insights from DayTIMe continue to influence their product portfolio.

In the longer run, DayTiMe expects to make positive contributions to the use-case domains and beyond. By shifting from reactive to predictive maintenance, unplanned downtime can be significantly reduced, resulting in fewer maintenance costs, better service quality and a lower environmental impact through less waste and resource usage. This will also increase the proactiveness of services, helping to increase customer satisfaction and even saving lives in critical domains such as medical supply systems.