ITEA 4

Project Results

MACHINAIDE

Leading the way to digital twin innovations for the smart factory

The ITEA project MACHINAIDE (Knowledge-based services for and optimisation of machines) has developed the use of digital twins and human-machine interfaces (HMI) in various industries while promoting their integration into a smart factory context by introducing novel solutions such as the Digital Twin Web.

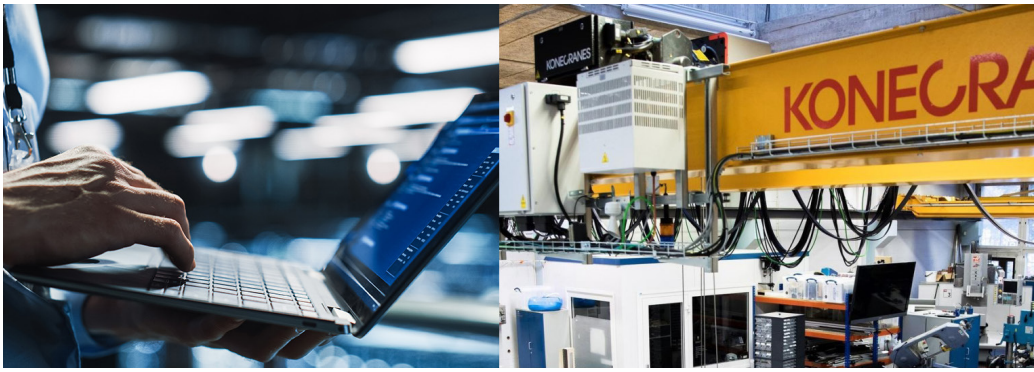
Traditional digital twins are often created on a case-by-case basis and utilise internal data models and heterogenous tools and formats. This means that machines and factories generate ecosystems that operate locally, yet the full potential of digital twins lies in connected ecosystems and HMI to better process information from these. New approaches and foundations must be developed to change the use of data from machine-readable to machine-understandable, enable standard data models and enhance drag-and-drop integration.

MACHINAIDE's primary goal has been to introduce and support new concepts for operating, servicing and managing the product lifecycle of machines in smart industrial applications. Three themes – connectivity, interoperability and exploitability – tie together use-cases in domains derived from five common objectives. Firstly, digital twins hosted by different ecosystems should be mergeable and manageable. Secondly, information from multiple digital twins should be represented in a unified manner. Thirdly, intuitive HMI should allow personnel to carry out operations easily and safely. Functional upgrades, parameter changes and the flexible adaptation of machines and processes should also be supported and enabled. Finally, new business models should be developed to exploit the results achieved.

Technology applied

MACHINAIDE has mostly focused on research for future developments. It has also created new ideas like the Digital Twin Web, a network of digital twins based on open standards that anyone can join by hosting a server on the internet. This would serve as a layer above conventional asset management systems, moving these from a strict case-specific structure to case-to-case information exchange. A key innovation to support this is the idea of digital twin description documents for integration, acting as common, systematic data sources for different systems via the internet. The consortium has applied digital twin documents in various ways. Dakik's Twinaide software, for instance, uses digital twin data from heterogenous sources to generate interoperable data that can be monitored and analysed on a single platform. Conversely, Aalto University's Twinbase software modifies digital twin documents to make them easily available and distributes them via an HTTP server that has both human and machine user interfaces. These innovations and others will enable digital twins to communicate beyond their local environments.

The project's other major achievements relate to HMI. In the Finnish use-case, this has focused on increasing the security of workers by allowing them to have a good representation of their space and whether actions will endanger others. This has resulted in prototypes for augmented reality glasses (Hololens), virtual reality crane driving and smart training (Varjo) and a low-code mobile application (Smart Factory Worklist). Another highlight was the Korean use-case in which web-based HMI systems and a mobile application have been created for the material handling domain, where digital twins can be used to represent robots and simulate different trajectories. MACHINAIDE's use-cases range from automotive production lines and agricultural feeding robots to 3D printing and smart factories, helping to illustrate the far-reaching benefits that a Digital Twin Web can offer.



New concepts for operating, servicing & managing product lifecycles of machines in smart factories

Making the difference

Thanks to the framework provided by ITEA, MACHINAIDE has been able to expand digital twin technology, including the new concepts of digital twin documents, API-based digital twins and the Digital Twin Web. For end-users, the benefits of such innovations are both financial and human-centred: MACHINAIDE's HMI innovations will allow workers to be safer and therefore more efficient, while connected digital twins will allow for more proactive monitoring of systems and therefore a longer mean time to breakdown and less machine downtime. Regarding commercialisation, the partners intend to exploit these results in a number of ways, including providing digital twin information directly to customer systems, (remote) monitoring of digital twins for maintenance purposes and smart factory orchestration. This will allow them to acquire a larger share of the global digital twin market, which is expected to reach USD 73.5 billion by 2027 at a compound annual growth rate of 60.6%.

The ultimate goal, however, is to develop and expand the idea of the Digital Twin Web to become open source and widely accessible. The current situation is comparable to the early days of the World Wide Web, with the need to move from a closed vendor situation to realise the most widescale benefits. This requires broad user acceptance, so MACHINAIDE is currently disseminating its results via, among other things, 27 scientific journal publications and involvement in 20 academic BSc, MSc and PhD works. Aalto University's Industrial Internet Campus (AIIC) has also created a virtual model for its smart factory research environment, allowing third parties to test the technical feasibility of their solutions in one platform and location and integrate these with other solutions. Finally, the project has participated in the joint working group to define an extension to the OPC-UA interfacing standard (VDMA) for a smart factory environment to support production line integration and material handling automation. Such results will improve international collaboration on digital twins to continue MACHINAIDE's work.

Major project outcomes

Dissemination

- 20 academic works completed and published (including 5 PhD dissertations)
- 27 articles published in academic / scientific journals
- 3 public Mechatronic Circus and DemoDay events arranged at Aalto University
- Participation in 28 conferences and workshops
- 6 series of academic lectures and courses arranged

Exploitation (so far)

- First field installations utilising the new standardized OPC-UA standard are in use

Standardisation

- Participation in the Joint Working Group together with Members from VDMA and FEM & OPC
- Foundation to standardise the OPC-UA Companion Specification for Cranes and Hoists

Patents

- 1 patent in preparation

Spin offs

- An international Association for developing the novel Digital Twin Web Initiative has been founded

ITEA is the Eureka R&D&I Cluster on software innovation, enabling a large international community of large industry, SMEs, start-ups, academia and customer organisations, to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth and benefits for society. ITEA is part of the Eureka Clusters Programme (ECP).

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Partners

Finland

- Aalto University
- IDEAL GRP
- Konecranes Global Coporation
- Remion
- RollResearch International Oy
- VTT Technical Research Centre of Finland Ltd.

Republic of Korea

- CIP System Ltd.
- ETRI Electronics and Telecomunications Research Institute

Netherlands

- Additive Industries
- CORDIS Automation B.V.
- Eindhove University of Technology
- KE-Works B.V.
- Lely Industries N.V.
- TNO

Türkiye

- Dakik Yazilim Teknolojileri
- Doğru Bilgi Teknolojileri
- Ermetal otomotiv ve esya sanayi tic.a.s.
- ERSTE Software Limited
- Teknopar Industrial Automation

Project start

October 2019

Project end

June 2023

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