The collaborators – navigating the AI ecosystem

Part of our Series “AI in the manufacturing industry”

Episode 3

pwc

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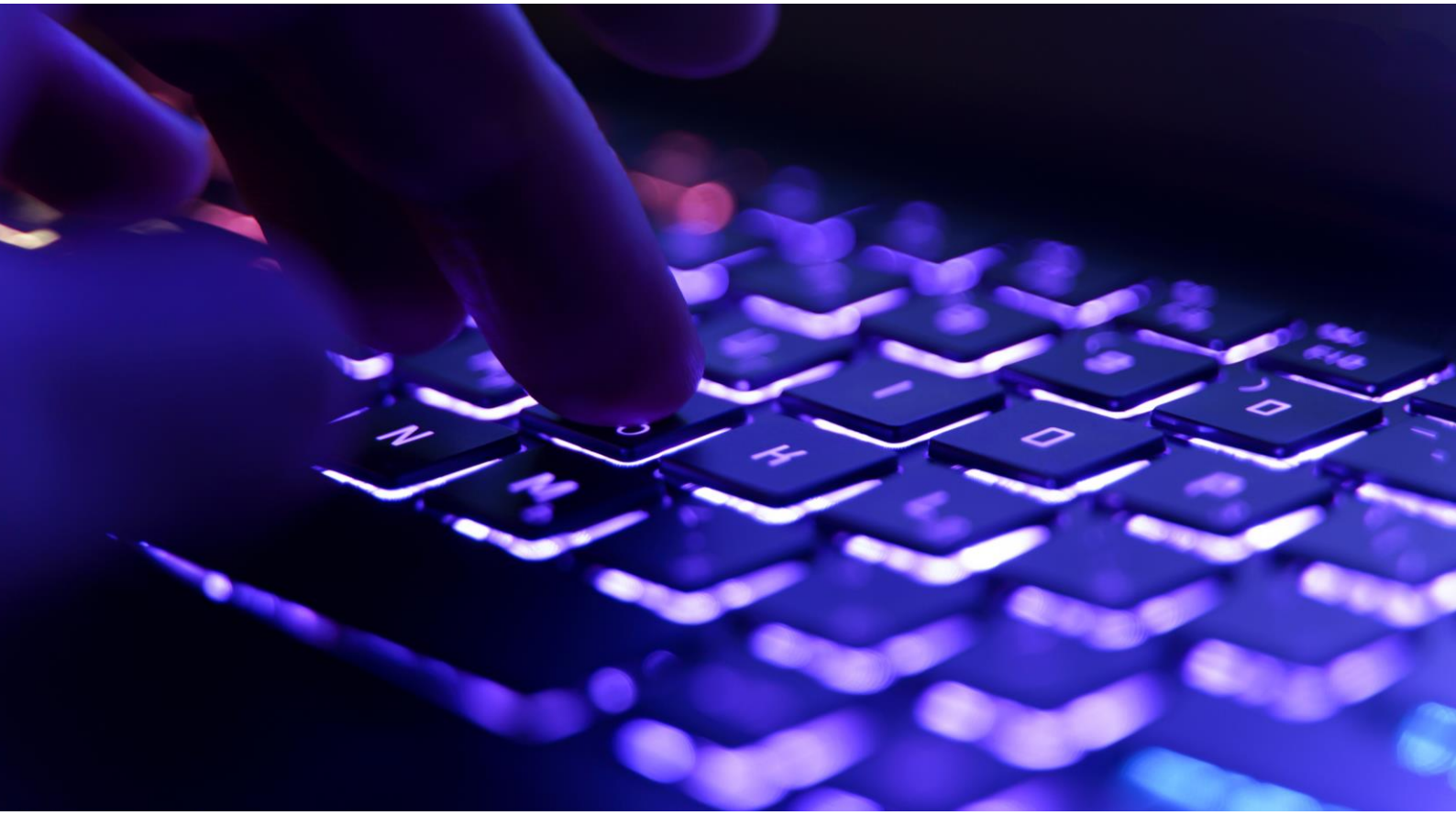
The series

Welcome to our series on the impact of Artificial Intelligence (AI) on the manufacturing landscape in Flanders and North Brabant, a joint project by PwC and OMC, the Open Manufacturing Campus. Our goal is to provide you with a comprehensive understanding of how AI is reshaping manufacturing and how it helps manufacturing companies improve their performance, innovation and sustainability, based on real world use cases from different sectors and regions.
We also share our insights and experiences on how to implement AI solutions successfully, addressing the technical, organisational and ethical challenges involved. Each episode delves into a specific aspect of AI, ensuring you gain valuable knowledge and actionable takeaways.
Throughout the series, our “AI in a nutshell” reference sheet provides the reader with an explanation on terminology and some fast facts.



This episode

In the third of our whitepaper series on AI in the manufacturing industry, PwC and the Open Manufacturing Campus (OMC) explore the key players in the AI ecosystem: End users, technology providers, consulting firms, academic institutions, government bodies and collaboration networks.

Each of these players brings unique capabilities that can be leveraged at different stages of the AI journey, from strategy and ideation to scaling and ongoing support. Together, they contribute to the successful deployment and scaling of AI solutions.

Value of an ecosystem

In today's rapidly evolving technological landscape, integrating AI solutions within production and manufacturing processes is essential. However, the complexity of AI solutions often requires expertise from multiple domains, some of which are typically not available in-house. While some companies choose to insource skills, others lack the extensive resources and financial capacity to build and maintain an in-house team. Smaller companies, in particular, face these budget limitations as they lack the scale needed to valorise the investment. Even if a company prefers to acquire the skills in-house, the war for talent might force them to look for skills elsewhere. Additionally, the rapid pace of AI development means that maintaining up-to-date knowledge and skills in-house is a continual challenge that many companies prefer to offload to specialised external partners. When faced with these struggles, companies can rely on an ecosystem of AI players for support.

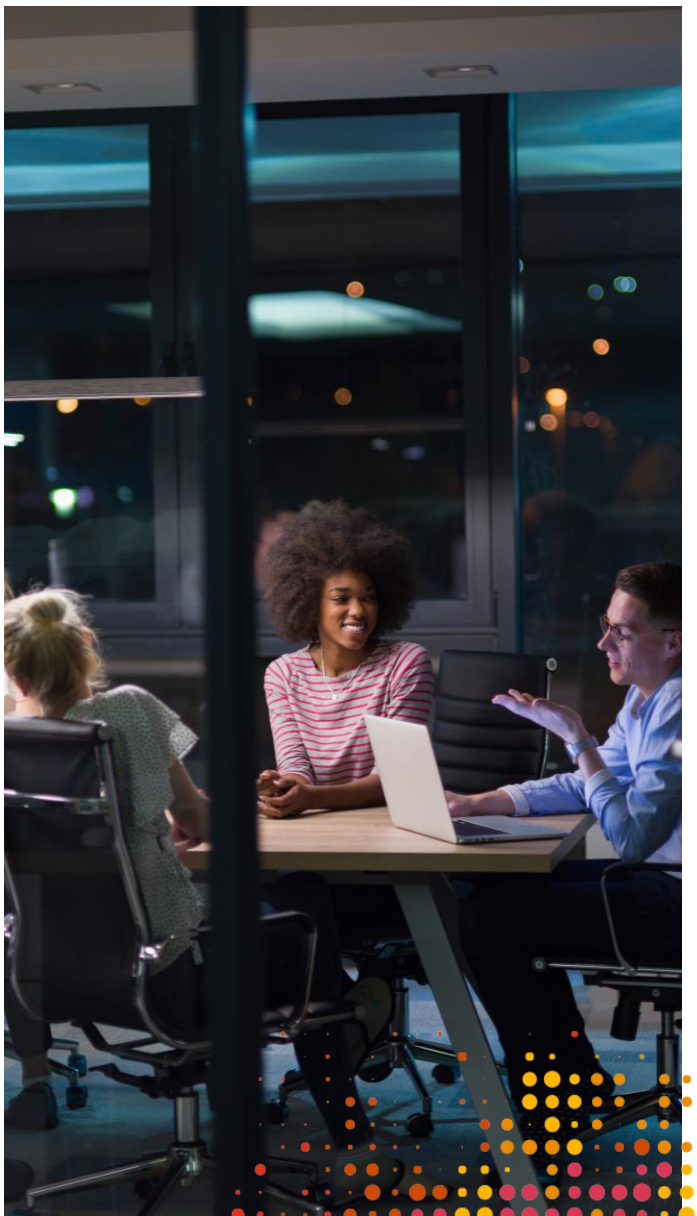
Collaboration can not only help address skill gaps but, more importantly, also facilitate the exchange of cutting-edge knowledge and best practices, driving collective learning and innovation. This shared expertise helps accelerate the development and deployment of AI solutions, enabling companies to stay ahead in a competitive market. Overall, by connecting to the AI ecosystem, companies can leverage diverse expertise and effectively navigate the complexities of AI implementation, from strategy to deployment and ongoing support, ultimately harnessing the full potential of AI to drive innovation and achieve long-term success.

Key players in the ecosystem

End users

End users of AI applications, amongst which are manufacturing companies, play a crucial role in the AI ecosystem by driving demand for innovative solutions and ensuring that AI technologies address real business needs. By providing real-world data and feedback, end users help technology providers and consultants imagine, design and continuously improve and optimise AI solutions.

It's important to understand end users' needs and frustrations and to involve them in the exploration, design and finetuning of AI solutions to ensure value delivery. End users should also be engaged in pilot projects to test AI applications in controlled environments, allowing for experimentation and refinement before full-scale implementation. This collaborative approach ensures that AI initiatives are practical, effective and aligned with the specific needs of the industry. The Sirris case (below) illustrates the value of end users; four production companies were involved in real-world testing and feedback gathering.



Technology providers

Large technology providers like Google, IBM, Microsoft, AWS, NVIDIA, Oracle, Meta and OpenAI offer essential tools and platforms that enable manufacturers to integrate AI into their operations. Technology providers develop advanced algorithms, machine learning frameworks, hardware accelerators and cloud-based services that facilitate and accelerate the development and deployment of AI solutions. Some examples of these state-of-the-art technologies are Google's TensorFlow, Microsoft's Azure AI, AWS's SageMaker, NVIDIA's GPUs and CUDA platform, Meta's PyTorch, IBM's Watson and OpenAI's GPT models. Alternatively, start-ups and smaller niche boutiques bring niche solutions that tackle challenges in specific industries or contexts. The PwC Scale programme on Excellence through AI featured some such start-ups. In addition to adopting off-the-shelf solutions to expedite AI integration, manufacturing companies can also collaborate with technology providers to develop solutions tailored to their specific needs. Depending on the use case and context, collaboration with smaller niche players might be beneficial as they tend to be more agile and can quickly adapt to the specific needs of a manufacturing company. By working closely with technology providers, users can also benefit from ongoing support, training and updates, helping them make sure that their AI initiatives remain cutting-edge and effective.

Consulting firms

Consulting firms like PwC offer strategic, technological and operational support for AI adoption. They help manufacturers develop comprehensive AI strategies aligned with business goals to make sure that AI initiatives deliver measurable value. Consulting firms also support the deployment and scaling of AI solutions. With access to a broad set of expertise in diverse domains (e.g. legal, technology, finance, etc.), consulting firms can connect the dots, making sure there's a holistic approach to AI integration and adoption. More specifically, they help with successfully implementing AI solutions into processes and new ways of working by tackling all necessary dimensions; people, security, trust and compliance. This is important as overlooking one of these dimensions can lead to a (partially) failed implementation or lower ROI. They also provide valuable benchmark data to help companies measure their progress and performance against industry standards. And they help inspire firms by sharing information about the latest trends and AI tools. Finally, they play a crucial role in guiding companies through the change management process, making sure that employees are adequately trained and that the organisation is prepared to embrace new AI technologies.

Academic institutions

The role of academic institutions is twofold. Firstly, universities and research labs often lead the way in AI research, planting the seeds to drive the industry forward. Collaborating with these institutions can provide access to the latest innovations and a deeper understanding of AI technologies. The case of Brubotics (below) illustrates how the Vrije Universiteit Brussel (VUB) leverages AI to improve robotic performance, contributing to the feasibility of more complex automation. Secondly, academic institutions provide a talent pipeline of AI-trained graduates. Engaging with academic institutions for internships, co-op programmes and to hire graduates secures a steady flow of skilled talent ready to contribute to AI initiatives.

In Flanders, a key player in the academic field of AI is the Flanders AI Research Programme. This is a consortium of 11 research institutes which focuses on strategic basic research into AI, aimed at the successful adoption of AI in the region. The institutes work within a quadruple helix ecosystem, involving research centres, governments, companies and non-profit organisations.

Government bodies

Government bodies play a vital role in regulating and promoting ethical AI practices. They provide compliance guidance to make sure that AI initiatives meet legal and ethical standards, reducing risks and building trust.

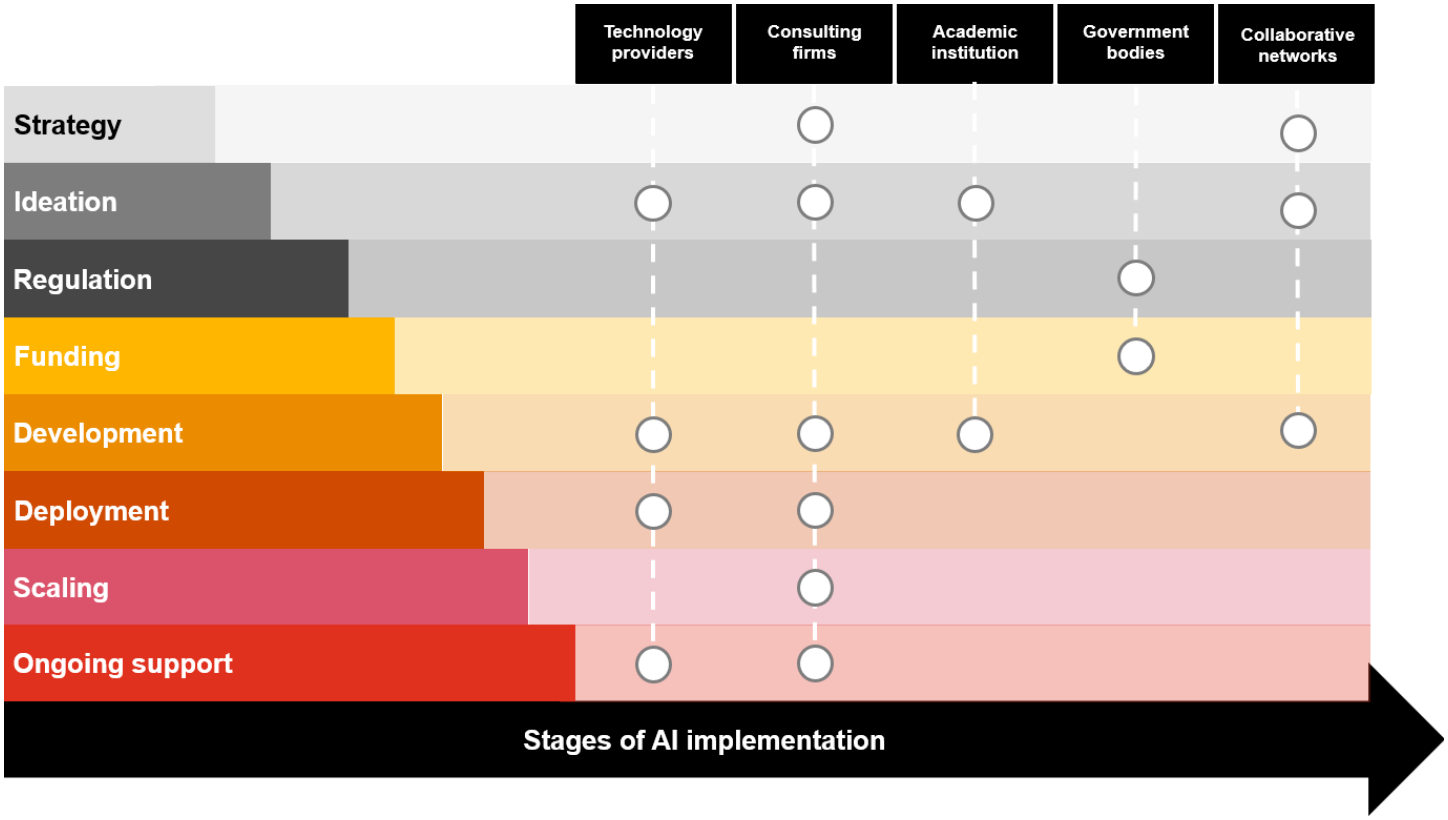
Governments also offer grants and funding opportunities to support AI research and implementation, providing additional resources to accelerate AI projects. For example, in Belgium, the Flemish Government launched the Flemish AI action plan, which allocates an annual budget of 32 million euros for AI implementation within companies and basic research and to support measures such as training and ethical considerations. With an annual budget of 18 million euros, the Walloon region's DigitalWallonia programme aims to accelerate AI adoption. These initiatives provide significant support to companies in the manufacturing industry, helping them develop and implement advanced AI solutions. For example, both case studies featured in this paper were supported by a VLAIO (Flanders Innovation and Entrepreneurship) grant. For more information on available grants and funding opportunities, visit the European Commission's website.

Collaborative networks

Collaborative networks are groups of companies and professionals with shared goals, providing a platform for collaboration and knowledge sharing. One example of this are industry associations (e.g. Agoria) which come together in a specific industry to promote common interests, advocate for policies and provide networking opportunities. They typically provide domain expertise and inform on latest trends and best practices. The Sirris case (below) highlights a pragmatic example of the role these institutions play in collaborations. Another type of collaboration network is created by innovation hubs. These hubs, often physical, create spaces to foster creativity, innovation and entrepreneurship across various sectors. They bring together start-ups, researchers and businesses to develop new ideas and technologies. Among other things, they offer coaching, workspaces and technical facilities. They aim to connect companies with similar interests to drive innovation. Examples are the Tech Lane Ghent Science Park and the OMC in Turnhout, both in Belgium.

Strategic collaboration

When navigating technological innovations, considering strategic collaboration is a good way to maximise value. Given the disruptive character of AI innovations, building and leveraging the AI ecosystem is paramount. Given the roles of the key players as highlighted above, the visual (below) gives an overview of when to consider which player.



However, collaborating within an ecosystem also presents several complexities. First, aligning priorities among academic institutions, government bodies and industry players can be challenging due to differing objectives and timelines. Secondly, securing funding requires navigating various grant opportunities and meeting specific eligibility criteria, which can be time consuming and competitive. Confidentiality is another critical concern, as sharing sensitive information across multiple entities necessitates robust agreements to protect intellectual property and proprietary data. These complexities demand coordination and clear communication to make sure that all parties achieve mutual benefit and project success.

Regardless of these complexities, successful AI implementations are deeply rooted in human connections. By fostering collaboration, stakeholders can combine their dedicated expertise, resources and innovative ideas to drive AI advancements which aren't just technically sound but also ethically and practically viable.

The case studies of Sirris and Brubotics (below) serve as prime examples of successful collaborations. Both cases highlight how the combination of knowledge and expertise from multiple players leads to successful projects. Firstly, the Sirris case shows how it, as an industry association, brings together manufacturers, researchers and technology players to tackle a long-standing challenge within the machining industry. Secondly, the Brubotics case shows how research institutes collaborate with end users and technology players to bring new innovations to market.

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sirris innovation forward

OPTIMISING TOOL WEAR DETECTION: SIRRIS, KU LEUVEN'S EAVISE TEAM AND TISEA TRANSFORM MACHINING WITH AI

CONTEXT

Monitoring tool wear is very important in the machining industry as worn-out tools may result in loss of dimensional accuracy of the finished product or even line stoppages through breakage. And, with consumables accounting for up to 10-20% of production costs, machining companies have every reason to optimise the timing of tool replacement. Hence, measurement of tool wear is extremely important, but difficult to tackle efficiently.

Sirris, a dynamic not-for-profit organisation founded and governed by industry, recognised this challenge. Together with KU Leuven's EAVISE team, four machining companies and TISEA, a machine integrator specialising in smart solutions, Sirris set up a collaborative research project to leverage AI to optimise tool wear detection and create a scalable, affordable solution that automates decision making and enhances precision.

CHALLENGE

Accurate tool wear assessment is crucial to avoid over-replacement, leading to waste. Conversely, under-replacement causes failures and costly downtime.

Traditional assessment methods based on historical data are often inaccurate as they don't reflect the actual state of the tool. Operator assessment, on the other hand, depends on the experience and availability of the operator, both of which are becoming scarce in today's factories.

So far, research into data-driven solutions has struggled with scalability and adaptability due to the diverse environments, products and production speeds across machining companies. The challenge was to develop a solution capable of adapting to diverse production conditions that could provide consistent and precise wear detection and integrate seamlessly with existing machining setups.

AI SOLUTION

The team introduced a hybrid AI-powered model which integrates two distinct approaches to enhance tool wear detection:

- **Sensor-based model approach**: Uses real-time data signals to predict tool status, but may return false positives
- **Camera-based model approach**: Uses machine vision to measure tool wear accurately, but requires machine stoppage for image capture.

The hybrid approach applies a two-step assessment: When sensors flag a potential issue, the camera-based model validates the findings with detailed image analysis using AI classification algorithms. This combination of sensor and camera-based models created a robust and reliable system for detecting tool wear, leveraging the strengths of both approaches to secure accuracy and efficiency.

IMPLEMENTATION APPROACH

The project took two and a half years to complete and was coordinated and managed by Sirris.

It was split into a basic research part, which was fully funded by VLAIO, and an applied research part. The basic research focused on the development of a machine vision algorithm to assess tool wear inline. The applied research then further investigated how to pragmatically use this method in production environments.

Each of the collaboration partners had their own distinct value. In addition to coordinating the project, Sirris also played a crucial role in data collection. Not only did the non-profit conduct lab tests using in-house production machines, but it also automated the collection of data. The latter is a significant advantage as it allows researchers to generate datasets representing diverse machining conditions, thereby laying the groundwork for robust model development. Finally, Sirris also supported the data analysis.

KU Leuven's EAVISE team had a pivotal role in the design and validation of AI models. The university team provided invaluable research insights and led the refining of the algorithms to enhance both accuracy and adaptability.

For the deployment and validation phase, four machining companies were engaged for real-world testing and feedback. This was key to refine the AI models, meet industry requirements and guarantee the solution's practical applicability.

Finally, device prototyping was a critical milestone. Machining manufacturer TISEA designed and built the final standalone device, ensuring it met industry requirements for affordability and usability. It was decided to focus on the second part of the method, vision-based detection.

The final product is an offline machine vision inspection device that can be installed in production environments, allowing operators to easily inspect tools.

RESULTS AND IMPACT

The project achieved an impressive 95% certainty in predicting tool wear. The main value add is improved product quality and machine failure avoidance, enhancing the overall reliability of the manufacturing process. This is estimated to offer an annual saving of around 10,000 euros on the consumption of tools.

Scalability was another key benefit, as the affordable device developed by TISEA made the solution accessible to small and medium-sized enterprises, allowing them to implement advanced tool wear detection without significant financial burden.

LESSONS LEARNED

Data challenges

A large amount of data is required to obtain robust AI models, so even though data capture was automated as much as possible, a lot of time and effort was still needed for the manual labelling of data.

Collaboration is key

Collaboration proved to be key, with partnerships involving KU Leuven, TISEA and various manufacturers enriching the project through complementary expertise. This diverse collaboration ensured a well-rounded approach and enhanced the project's success. Sirris and its partners exemplified the power of collaboration in driving technological advancements.

Hybrid models work

Additionally, the implementation of hybrid models, which combined sensor- and camera-based approaches, addressed individual limitations and resulted in a more reliable system. This innovative combination provided a comprehensive solution to the challenges faced.

CONCLUSION

The collaboration between Sirris, KU Leuven, TISEA and industry partners shows that by blending research, industry input and innovative technology, a transformative solution can be delivered that optimises tool wear detection and reduces waste.

The success of this initiative provides a roadmap for other manufacturers exploring AI adoption. With the right partnerships and a collaborative ecosystem, companies can achieve smarter, more efficient operations.

Could AI help your manufacturing operations overcome challenges and drive innovation?

Industrial automation

BRUBOTICS AND MELEXIS - ADVANCING ROBOTIC MANIPULATION WITH TACTILE SENSORS

CONTEXT

Touch sensors are essential for ensuring safe interaction between robots and humans, as well as to enable precise object manipulation. Most touch sensors, however, measure only normal force and fail to account for shear forces, a limitation that poses significant challenges for many applications. This limitation complicates efforts by manufacturers to automate processes requiring sensitivity and precision, as robots often struggle to handle fragile or complex items effectively.

Recognising this challenge, Melexis, a global supplier of micro-electronic semiconductor solutions, has been developing magnetic touch technology that addresses the need for shear force detection. With the support of the VLAIO-project SKINAXIS, Brubotics, a multidisciplinary consortium of eight research groups from the VUB, is applying this technology to robotic use cases, creating innovative solutions for safer and more precise robotic interactions. This work also has significant potential for wearable applications, such as exoskeletons and prostheses, where detecting shear forces is key to improving comfort and alignment between the device and the user.

CHALLENGE

Robots primarily rely on vision and, to a lesser extent, audio to perceive their environment. While visual sensors provide valuable data, they often fall short in tasks requiring delicate manipulation, where tactile feedback becomes crucial. Unlike human skin, which serves as both a protective layer and a sophisticated sensory organ, robotic "skin" is largely passive and lacks the sense of touch. This absence limits robots' ability to handle objects with the dexterity and precision of humans.

Giving robots the sense of touch has long been recognised as a key challenge, with the goal of developing a touch-sensitive robotic skin that can dynamically adjust grip force to handle objects with varying properties such as softness, texture and fragility, without causing damage or slippage. This technology is essential for safe and effective human-robot collaboration and enables robots to interact confidently in complex environments that demand high adaptability and precision.

Cases – Brubotics & Melexis

AI SOLUTION

Brubotics is enhancing robotic gripper performance by integrating Melexis' Tactaxis sensors with AI capabilities. These tactile sensors provide a 3D force vector that acts on their surface. Brubotics incorporates these sensors into robotic hardware and is developing an AI model that interprets sensor signals, predicts slippage and regulates gripper force to maintain a secure grip without object deformation. The research is ongoing and the AI model is being refined to enable more effective object grasping

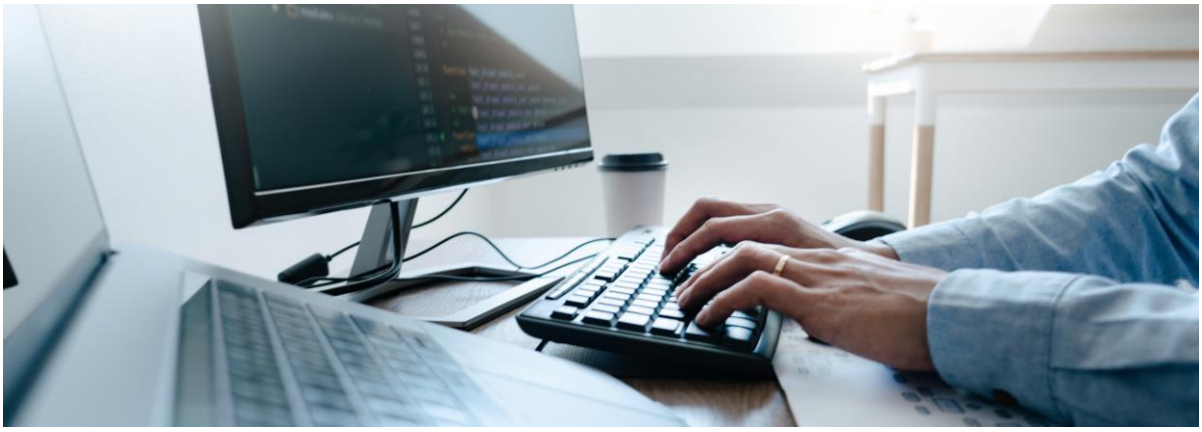
IMPLEMENTATION APPROACH

Development of an AI model requires extensive training. Since training AI in real life to handle various objects is time-consuming due to the vast number of possible/types of objects in the world, simulations in virtual environments are used instead. However, these virtual environments also require pre-existing data, so Brubotics uses NVIDIA's Isaac Sim tool to create virtual environments which allow the use of pre-created object datasets. This digital twin approach speeds up AI training, making it more efficient and better preparing it for real-world tasks.

Once successful in simulation, Brubotics will transition the solution to real-world applications, evaluating the sensor's performance and refining it further. Through iterative design and simulation, the aim is to optimise both hardware and software for multi-robot learning, enabling robots to share data and adapt their control policies across different hardware systems, thereby enhancing overall performance.

To verify integration, a mathematical model of the sensor will be developed and experimentally validated. The model will also capture sensor limitations. The impact of these limitations will be systematically quantified for each application use case. Concretely for the robot grippers, the 3D touch sensor measurements will be benchmarked against the interaction forces recorded by manually labelled cobot data.

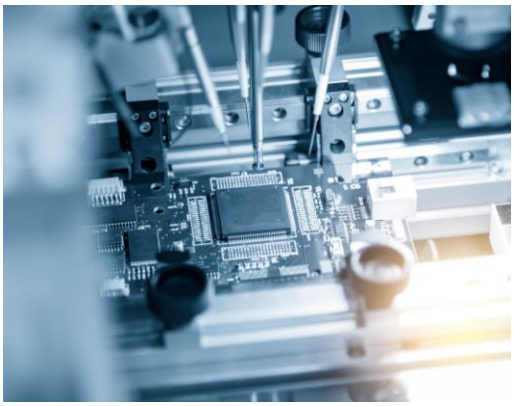
Melexis is continuously improving the performance of its Tactaxis sensors and upscaling for their cost-efficient introduction into various robotic cases. Based on specific use cases in robotics, Brubotics defines the sensor requirements, develops the AI algorithms for human movement intention detection and provides performance feedback to refine the sensor design.



Cases – Brubotics & Melexis

RESULTS AND IMPACT

Brubotics has successfully prototyped this technology in rehabilitation centres, where the robot detects the patient's movement and provides assistance as needed. Additionally, the technology has been integrated into a functional prototype for tasks like fruit picking, demonstrating its broader applicability. By equipping robots with the ability to perceive and respond to physical forces, this innovation enhances the safety, precision and efficiency of human-robot interactions. It opens up new possibilities for seamless collaboration across a wide range of industries.



LESSONS LEARNED

AI for faster testing

Instead of relying on real-world data, Brubotics used simulations to replicate real environments and train policy models. This approach accelerated the testing and development process, allowing for quicker iterations and more efficient refinement of the technology.

Compact, lightweight and cost-effective

The tactile sensor developed by Melexis is significantly more compact, lightweight and affordable compared to state-of-the-art alternatives. This makes it easier and more cost-effective to integrate into future robotic systems, broadening its potential for widespread adoption.

Enhanced robotic manipulation

A wide range of grippers, humanoid robots and robotic hands available on the market could benefit from this technology to enhance their manipulation capabilities. The findings from this research can provide valuable insights and improvements for these systems, making them more effective and versatile.

CONCLUSION

The collaboration between Brubotics and Melexis showcases the transformative impact of Tactaxis sensors in enhancing robotic manipulation. This technology delivers substantial advancements in the performance and adaptability of robotic systems across a wide range of industries.

The success of this project paves the way for other companies looking to enhance their robotic capabilities through tactile sensing. With the right strategic partnerships and a focus on innovation, businesses can optimise efficiency, safety and precision in a range of applications.

Closing

Understanding the perspectives of different players in the AI ecosystem is crucial to be able to successfully navigate the AI journey. Technology providers offer essential tools and platforms, consulting firms offer strategic and operational support and academic institutions provide cutting-edge research and a pipeline of AI-trained graduates. Government bodies offer regulatory guidance and financial support. Collaboration networks and non-profits facilitate collaboration, knowledge sharing and the development of best practices. By leveraging the unique capabilities of these key players while navigating the complexities of these collaborations, the manufacturing industry can implement advanced AI solutions effectively, driving innovation and maintaining a competitive edge.

Coming up

In our next whitepaper, we're diving into the social and ethical elements of AI. We'll explore how AI impacts different personas within your organisation and discuss strategies for engaging and upskilling your workforce. We'll also tackle some of the big ethical considerations and look at the evolving landscape of regulation and governance. Plus, we'll share some success factors and common pitfalls to watch out for. You won't want to miss it!

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