



KEY FACTS

Acronym: IMOCO4.E

Full name: Intelligent Motion Control under Industry4.E

Coordinating institution: Sioux Technologies B.V.

Project coordinator: Arend-Jan Beltman

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Start date: 1st September 2021

Duration: 36 months

Consortium: 46 Partners from 13 countries

This issue provides a grasp of the main project developments during March 2022 – June 2022. It also provides facts on the results achieved, as well as links to the latest dissemination activities.

During the past 3 months and within the technical work packages defined the overall requirements of the IMOCO4.E reference framework and have started the first activities in the development and implementation. We are also proud to announce that in the past three months the IMOCO4.E partners participated and represented the project successfully in several events, submitted 14 publications in journals and conferences, while at the same time started the preparation for the 1st promotional video.

IMOCO4.E
Highlights

WHAT HAS BEEN DONE?

WP2 have submitted three public deliverables. The task T2.1 on 'what does future smart production and/or manufacturing require from emerging mechatronic technologies' have concluded with the submission of the deliverable D2.2 on needs for future smart production (manufacturing) in Europe from the mechatronics and robotics point-of-view.

Task T2.2 on 'the inventory of the state-of-the-art of IMOCO4.E technologies' have also concluded with the submission of the deliverable D2.1 on 'state-of-the-art methods in digital twinning for motion-driven high-tech applications. Task T2.3 on the IMOCO4.E reference system architecture is active and had submitted its first deliverable D2.3 on the overall requirements of the IMOCO4.E reference framework. Currently, WP2 is working on creating synergy between the technical work packages in the IMOCO4.E project and will work towards the general specification and design of the IMOCO4.E reference framework.

WP2

ToC

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What has been done

Partners involved in the WP3 continued work on requirements and specifications of the perception and instrumentation layer. Requirements were collected and are currently used to prepare an upcoming deliverable D1.3. Remaining tasks T3.2-T3.5 dealt with the developments of the layer's technologies, while still clarifying connections between some of those technologies and project's use-cases, pilots, and demonstrators. Several novel sensors were specified in T3.2, and first developments begun. Similarly, T3.3 specified and started the development of seven FPGA, SoC, or multi-many core platforms, T3.4 started development of ten AI-based perception modules, and T3.5 started development of high-speed servo drives and variable speed drives.

WP3

WP4

Partners in WP4 are working flat out as all tasks of the work package are already running. Efforts are focused on Task 4.1, where the control technologies to be developed and their corresponding requirements must be defined. All other tasks, apart from feeding task 4.1, have started their own developments and checking the needs of IMOCO 4.E Pilots, Use Cases and Demonstrators. Task 4.2 is finalizing a state-of-the-art in the field of XiL methodology for control system design based in Digital Twins. This will be the first step towards the definition of a common approach within IMOCO4.E framework.

Tasks 4.3 and 4.4 have started the first activities in the development and implementation of new decentralized and centralized control algorithms for mechatronic systems, that will constitute IMOCO4.E Building Block 5. Potential control algorithms include Repetitive Control, Model Predictive Control or advanced Learning Control techniques. Task 4.5, linked with IMOCO4.E Building Block 10, has started their activities in the field of path planning, route optimization, and decision making (collision avoidance) of mobile robots. Specific functionalities in development are Control and vision algorithms for boom robot and the implementation of fleet management system. Finally, Task 4.6, linked with IMOCO4.E Building Block 4, is performing the first steps towards the development of low-cost control hardware for advanced performance like Artificial intelligence, high speed vision in the loop functionalities.

WP5 has been fully operational since the beginning of April 2022. All tasks in WP5 are running, and teleconferences between partners are organized in monthly meetings. Partners are discussing common interests, and groups of cooperating partners are being established. These connections, together with the understanding of links between building blocks and pilots, use cases, and demos, help to define requirements and specifications, which are collected through Task 5.1 in deliverable D5.1. Task 5.2 gathers the requirements for data exchange and specific cyber-security categories. Tasks 5.3 and 5.4 are the main contributors to BB6. Therefore, the requirements for condition monitoring, predictive maintenance, and self-commissioning of industrial motion control systems are analyzed between partners. The original structure of subtasks in Task 5.5 has been revealed to be challenging to work with. The thematical subdivision was rather restructured according to cooperating partners, which makes the preparation of requirements on complex systems modeling more straightforward. Task 5.6 has investigated the use of digital twins. Thoughts on their behavior, on the hardware capable of operating them in real-time, and on enhancing DT with virtual reality are translated successively into requirements and specifications. In the last task, besides initiating work on AI methods for monitoring and predictive maintenance on higher IMOCO4.E layers and defining the cutting edge between the BB6 and BB9, also launched the process of gathering requirements and specifications for D5.1. Finally, WP6 has recently started (M9- May2022) so there are no updates so far.

WP5

Dissemination & Communication

IMOCO4.E values the importance of networking, exchanging ideas and knowledge with other similar EU projects. The consortium has managed to generate discussions with H2020 TIBCO, METIS and MADEin4 aiming at the co-organization of special sessions as well as boosting joint dissemination activities.

Liaison activities are in progress

During the reference period, the partners have intensively disseminated the project results by spreading knowledge and creating good networking opportunities with industrial and scientific peers. The IMOCO4.E partners have focused to widen up the network of scientific experts of the project and transferred valuable scientific results by participating in multiple online and physical conferences and workshops. Visibility of the project and transferability of the project outcomes has been promoted through the update of the [promotional material](#) (released a new poster, brochure, banner) and by regular dissemination to the public through social media channels.

During the past 3 months and in the context of WP8 activities, IMOCO4.E participated in the several events, such as:

IMOCO4.E partners attended KDT Brokerage in Brussels during May 3rd - 4th 2022. (Representative partner: UWB). More details [here](#)

Dutch Society for Precision Engineering Lunch Lecture, 7 Mar 2022, online (Representative partner: ITEC).



DSPE LUNCH LECTURE: **DSPE**

Iterative learning control enables a next breakthrough in die bonder throughput

Monday March 7th 2022, 12:02-12:30 hours, online

Speakers: Jasper Wesselingh and Gijs van der Veen from Nexperia ITEC

Nexperia ITEC constantly strives to improve throughput and lower the cost of ownership of its die-bonding solutions. An important milestone is to increase die bonder throughput from 72.000 to 100.000 units per hour by the end of this year. To achieve this, faster and tailored setpoints are required on core motion axes of the die bonder. In this lunch lecture we show how iterative learning control is used to adapt feedforward parameters in runtime, maintaining a short settling time with these aggressive setpoints.

A 3D plot showing error e_i (µm) on the vertical axis (ranging from -1 to 1) against time (ms) on the horizontal axis (ranging from 0 to 50) and task # on the depth axis (ranging from 0 to 12). The plot shows multiple colored lines representing different tasks, all showing a similar oscillatory behavior that decays over time.

As key European innovation project, the IMOCO4.E consortium was a welcomed addition to 2022's Industry Strategy Symposium Europe to share its achievements and views on the future of Industry 4.0 manufacturing. 30 May 2022, Brussels (Representative partner: SEMI). More details [here](#)

Chips in Europe Webinar, 13 June 2022. Emphasizing key concepts of the project, the session speaker Sajid Mohammed from ITEC (Figure 2) captivated the audience's attention by focusing on the project's key concepts of artificial intelligence and digital twins, (Representative partner: ITEC). More details [here](#)



In addition, IMOCO4.E partners plan to participate in:

- MEMS & IMAGING Sensors Summit, 6-7 Sep 2022, Grenoble, France – Event [Link](#)
- ETFA 2022, 27th International Conference on Emerging Technologies and Factory Automation, 6-9 Sep 2022, Stuttgart, Germany - [Event Link](#)
- Semicon Europa, 15-18 Nov 2022, Munich, Germany – [Event Link](#)
- EF ECS Event, 24-25 Nov 2022, Amsterdam – [Event Link](#)

Special Podcast Sessions & 1st promotional video Coming Soon!!

Although the outreach activities continue with weekly posts on social media platforms (LinkedIn and Twitter), the IMOCO4.E team plans to increase knowledge and visibility of the project by raising awareness of the benefits of the IMOCO4.E platform on specific use cases and demonstrators via special podcast sessions! Additionally, the 1st promotional video planned to be ready by the end of July and will be an animated project intro video.

Consortium Meetings, Publications & Submitted Deliverables

On regular basis, several administrative and technical consortium meetings are taking place in order to discuss project status, updates, progress and next steps. Consortium will prepare the 2nd Consortium meeting, which will be held on 20-22 of September 2022 physically in Riga, Latvia and the 1st Review Meeting on 15th of November 2022.

IMOCO4.E Publications

The IMOCO4.E project also tries to have an active performance via conference paper publication by presenting the research work carried out in the frame of the project. The list of upcoming presented articles is shown below:

- "Dynamic Model Learning of Compliant Robots", IEEE TNNLS Journal, Brayan Valencia-Vidal, Eduardo Ros, Niceto R. Luque
- "Ablation Study of a Person Re-Identification on a Mobile Robot Using a Depth Camera", IEEE ISIE22 Conference, Sebastian Flores, Jana Jost
- "Digital Twins and HIL Simulators in Control Education – Industrial Perspective", IFAC ACE 2022 Conference, M. Cech, M. Vosahlo
- "Raspberry Pi-based Motion Control Testbed for Mechatronics Education", IFAC ACE 2022 Conference, Martin Goubej, Luk as Blaha
- "Frequency Domain Identification of Multirate Systems: A Lifted Local Polynomial Modeling Approach, CDC 2022 Conference, Max van Haren, Lennart Blanken, Tom Oomen
- "NC controlled robot for adaptive and constant force 3D polishing", ETFA 2022 Conference, Diego Gonzalez, Mikel Armendia
- "Optimal Commutation for Switched Reluctance Motors using Gaussian Process Regression", Modeling, Estimation and Control Conference 2022, Max van Meer, Gert Witvoet, Tom Oomen
- "Design of robust PI controller by combining robustness regions with time-domain criteria", ETFA 2022 Conference, Vilem Zan, Karel Kubicek, Martin Cech
- "Ablation Study of a Person Re-Identification on a Mobile Robot Using a Depth Camera", IEEE ISIE22 Conference, Sebastian Flores, Jana Jost
- "Digital Twins and AI in Smart Motion Control Applications", ETFA 2022 Conference, Martin Cech, Arend-Jan Beltman, Kaspars Ozols
- "Comparing repetitive control strategies in lift applications", ETFA 2022 Conference, Roberto Fausti, Manuel Beschi, Davide Colombo, Antonio Visioli
- "An Evaluation Framework for Vision-in-the-Loop Motion Control Systems", ETFA 2022 Conference, Chaitanya Jugade, Daniel Hartgers, Phan D'uc Anh, Sajid Mohamed, Mojtaba Haghi, Dip Goswami, Andrew Nelson, Gijs van der Veen, and Kees Goossens
- "Sim2Real image translation to improve a synthetic dataset for a bin picking task", ETFA 2022 Conference, Diana Duplevska, Maksims Ivanovs, Janis Arents and Roberts Kadikis

Submitted Deliverables

- D2.2 - "Needs for future smart production in Europe from the mechatronics and robotic point of view"
- D2.3 - "Overall requirements on IMOCO4.E reference framework"



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