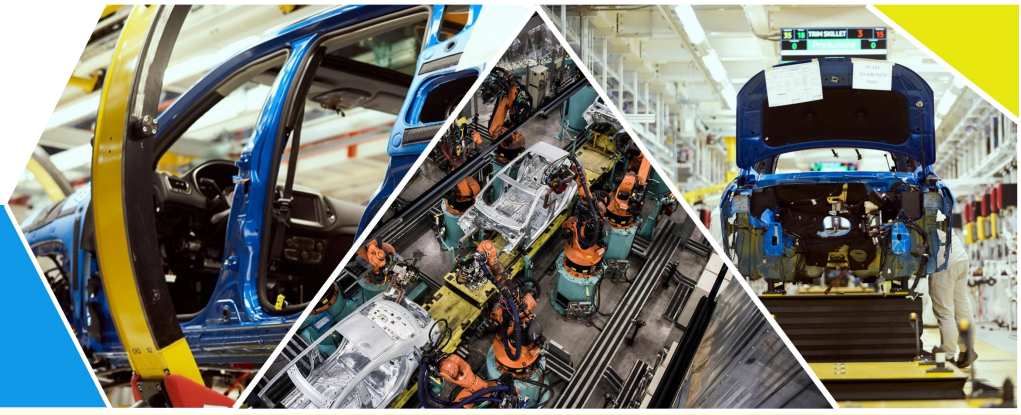
FELICE
NEWSLETTER Nb.5



Development updates | News | Publications & Press

Updates

Milestones

Implementation and demonstration of **Phase II prototypes** are progressing

Additional demonstrations of the FELICE system will be conducted in September 2023

The consortium is preparing for the **second project review** in November 2023

Development Updates

Presentation of the FELICE project at CRF in Melfi, Italy

The advanced training seminar on Industry 5.0 and Plant Sustainability held on May 16 at the CRF Campus Manufacturing in Melfi was an opportunity to show the participants the activities carried out within the project FELICE. The project was presented to managers and technicians of the Automotive cluster of Basilicata, highlighting the potential of human-robot collaboration in assembly processes to increase productivity and flexibility.

Participants showed relevant interest in the issues, and this resulted in a discussion with questions and observations. Along the assembly line at the CRF in Melfi, seminar participants were able to observe how a collaborative robot can realistically interact with operators on the line and also were able to understand how other technologies developed as part of the project, such as adaptive workstations, digital twin of the line and artificial intelligence algorithms can support line productivity.

Fast Facts

- Training seminar at CRF with a focus on human-robot collaboration

Digital Twin: Virtual Simulations of the assembly

The work on the Digital Twin Real Time Virtual Simulation module (that is the second module of the Digital Twin to be released in phase II of the project) is ongoing, and it has now included a number of new features and functionalities.

3D animations of Assembly Stations at CRF have been split according to the workflows modeling being defined for the FELICE system. A collaboration activity is also on going with PROFACTOR and FORTH to integrate the robot as part of the Digital Twin (basically, the robot will act in the Digital Twin environment as it will do in the real system). These functionalities will allow, in the next weeks, to have the Orchestrator controlling the Digital Twin Real Time Virtual Simulation Environment. Also, the simulation has been improved with a better times estimations for each single activity. Furthermore, in order to improve the quality of the work, a preliminary set of verification and validation activities for the Digital Twin Virtual Simulation have been done (in preparation of the work to be done with FHOOE for official verification and validation activities).

In conclusion, the Digital Twin activities are running on schedule and further news will be communicated in the next weeks.

Fast Facts

- Ongoing development to **enhance functionality** of the Digital Twin module
- Preparation for official **verification & validation** activities

TU Darmstadt updated the architecture of the Adaptive Workstation (AWS) to include the added tablet PC and the adaptive light system.
The AWS includes the lifting column as previously and was expanded with two linear actuators, so it can adapt to the work object's inclination as an additional degree of freedom. To stabilize the AWS, two linear guides are mounted to parts of the frame. These parts are also used to deliver parts of the forces and torque in the not moveable frame.

Simulation environment for lighting evaluation

Fast Facts

- **Tablet PC** and **Adaptive Light System** included
- **Simulation** of the Adaptive Light System addresses shadow and glare issues

The Adaptive Light System (ALS) tackles the problem of shadows and glare when the work object is moved up and down or rotated towards the worker. To simulate the influence of different lamps and their position, the simulation tool DIAlux evo is used. The simulation includes also the influence of daylight and the light system in the environment.
In addition to the simulations, the mechanical parts were implemented in the phase II prototype at TUD.

Human-robot collaboration in FELICE

The introduction of human-robot collaboration does not necessarily result in improving work. From the point of ergonomics, automation technology should also result in an increase in human well-being. This is one major focus of the FELICE project. How can the resilience and endurance of a robot be combined with the cognitive abilities of humans? Classically, optimizing workflows between humans and robots is about increasing performance or efficiency. But what does optimizing well-being look like? In the case of FELICE, we are talking about a mobile robot that works alongside humans on an assembly line. It can be used in various work situations and, for example, hands over tools and components to the human that are needed for the production process. Hence, the robot is about to become an assistant that supports the human through collaborative work. This also requires determining individual timing.

Fast Facts

- Mobile robot to **improve worker well-being** through collaboration
- Current activites to ensure **safety** and **robot acceptance**

IfADo researchers are involved in specifying and helping to shape the requirements for collaboration with the robot. In this context, safety is paramount in human-robot collaboration: on the physical level, for example, there is a risk of collision. On the cognitive level, the necessary as well as the available information must be planned during collaboration and execution of actions. IfADo evaluates and assesses the interaction and pays particular attention to aspects of user-friendliness and acceptance of the robot as an assistant.

Speech command recognition in FELICE

UNISA is working on Phase II of the FELICE prototype system, improving the speech command recognition subsystem deployed on board of the adaptive workstation and the robot. In the integration meeting held in Melfi at the end of May, the module developed by UNISA controlled the height and inclination of the adaptive workstation using voice commands. Furthermore, the operator can ask the robot to take specific tools, namely a screwdriver or a control panel. Using this technology, the operator can change the workstation settings without interrupting the assembly operations he/she is carrying out on the vehicle door and can avoid to waste time searching for and getting the tools needed for the assembly task.

Fast Facts

- Improvement of **speech command recognition** to control workstation adaptation

FELICE NEWS

For more FELICE News & Blogposts click here: News - FELICE (felice-project.eu)

Research Update by Fraunhofer ILM

Fraunhofer IML is currently working on the detection of the stress of human workers utilizing a Brain Computer Interface (BCI). Simple cognitive tests are conducted with several subjects. At the end, the subjects have to complete a questionnaire in additon.

This helps the researchers to better understand cognitive load under certain circumstances and help robotic assistants to adapt to the workers' needs in stressful situations. Additionally, the team at IML is evaluating a variety of trajectory planners for industrial robots.

Findings will help to adequately adapt the robot's motion to the human in a way he feels comfortable when collaborating with robots.

Update: Digital Twin

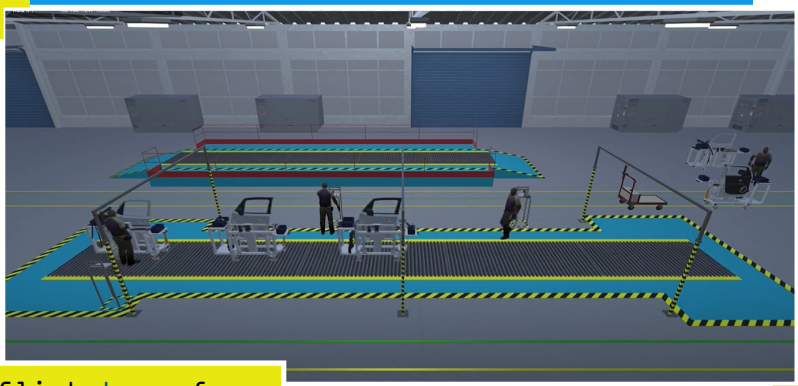
Real-Time Virtual Simulation is an approach to provide a more realistic testing environment for the Orchestrator managing the assembly workflow. The system checks the validity and the effects of the decisions taken to manage the assembly line. It provides a real-time simulation where, as much as possible, the physics of the entities and sensors are considered for the Human operators, for the robot (also using a ROS connection), and for the adaptive workstation. The platform for developing the Real-Time Virtual Simulation is Unity3D (for its real-time simulation capabilities and flexibility in terms of the programming environment). The simulation environment can be used manually by a human user to carry out real-time simulations and experimentations or automatically by the Orchestrator. A set of equations are defined and implemented to model the human operators' efficiency while considering the operations being done, working time, and ergonomic penalties. The simulation also includes a real representation of the robot and its status.

Development Update: FHOOE Demonstrator

Within the FELICE project, besides the main showcase at CRF in Melfi, a second alternative showcase is in use. This demonstrator is developed at the R&D department of the University of Applied Sciences Upper Austria. The goal of this second demonstrator is to prove the versatility and ease of use of the FELICE framework and to test various components in an additional environment. The basic components of the demonstrator are the same as for CRF: FIWARE as the central communication protocol, the Orchestrator for planning, executing and analyzing workflows, and a database for recording various test runs. Fundamentally, all FIWARE entity definitions were also adopted to keep the second demonstrator as close as possible to the main showcase. Furthermore, a MiR100 as a mobile platform, a UR10 as a collaborative robot, a work table with equipped worker assistance systems, a stereo camera system for the detection and evaluation of worker posture/ergonomics, as well as a speech input/output system are used in the demonstrator. Although these components differ in a natural way from the setup in CRF, the same interfaces have been implemented which allow the underlying hardware to be fully abstracted and interchangeable. This enables the execution of workflows both in CRF and at the campus Wels without having to make any changes to workflows. This infrastructure provides us with the ability to test new workflows and iterate more quickly on changes without having to rely on the setup in CRF. In addition, the Orchestrator software is deployed as Docker containers using remote deployment pipelines equally in both CRF and Wels. This helps us to validate the software and also to detect errors at an early stage before they can emerge in CRF during major integration activities.

New Felice Video—Virtual Simulation of car door assembly using FELICE Digital Twin Module

The Digital Twin adaptive workstation is just one element of the FELICE system, which unites multidisciplinary research in collaborative robotics, AI, computer vision, IoT, machine learning, data analytics, cyber-physical systems, process optimization, and ergonomics to deliver a modular platform that integrates and harmonizes an array of autonomous and cognitive technologies to increase the agility and productivity of a manual assembly production system, ensure the safety and improve the physical and mental well-being of factory workers.



Click here for the video!

Publications & Press

Scientific Publications

Akkaladevi, S. C., Propst, M., Hofmann, M., Hiesmair, L., Ikeda, M., Chitturi, N. C., & Pichler, A. (2021). Programming-Free Approaches for Human–Robot Collaboration in Assembly Tasks. In Advanced Human-Robot Collaboration in Manufacturing (pp. 283–317). Springer International Publishing.
DOI: https://doi.org/10.1007/978-3-030-69178-3_12
Link: https://link.springer.com/chapter/10.1007%2F978-3-030-69178-3_12

Conference publications

Lourakis, M., & Terzakis, G. (2021). A Globally Optimal Method for the PnP Problem with MRP Rotation Parameterization. In 2020 25th International Conference on Pattern Recognition (ICPR). 2020 25th International Conference on Pattern Recognition (ICPR). IEEE.
DOI: https://doi.org/10.1109/ICPR48806.2021.9412405
Link: https://ieeexplore.ieee.org/document/9412405

Jost, J., Kirks, T., Chapman, S., & Rinkenauer, G. (2021). Keep Distance with a Smile - User Characteristics in Human-Robot Collaboration. In 2021 26th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA). 2021 IEEE 26th International Conference on Emerging Technologies and Factory Automation (ETFA). IEEE.
DOI: https://doi.org/10.1109/ETFA45728.2021.9613601
Link: https://ieeexplore.ieee.org/document/9613601

Pratheepkumar, A., Hofmann, M., Ikeda, M., & Pichler, A. (2022). Domain Adaptation With Evolved Target Objects for AI Driven Grasping. In 2022 IEEE 27th International Conference on Emerging Technologies and Factory Automation (ETFA). IEEE. (25.10)
DOI: https://doi.org/10.1109/etfa52439.2022.9921470

Dimolianis, M., Kalogeras, D. K., Kostopoulos, N., & Maglaris, V. (2022). DDoS Attack Detection via Privacy-aware Federated Learning and Collaborative Mitigation in Multi-domain Cyber Infrastructures. In 2022 IEEE 11th International Conference on Cloud Networking (CloudNet). IEEE. (11.22)
DOI: https://doi.org/10.1109/cloudnet55617.2022.9978815

Pateraki, M., Sapoutzoglou, P., Lourakis, M. (2023) Crane Spreader Pose Estimation from a Single View. In 18th International Conference on Computer Vision Theory and Applications - VISAPP 2023
DOI:

Holzinger, F., Beham, A. (2023) Multi-criteria optimization of workflow-based assembly tasks in manufacturing. In Lecture Notes in Computer Science
DOI: https://doi.org/10.1007/978-3-031-25312-6_5

Pätzold, M. (2023) Adaptive positioning of large work objects to reduce physical load in industrial assembly -Adaptive Positionierung großer Arbeitsobjekte in der industriellen Montage zur Reduktion von physischen Belastungen. In 69th GfA spring conference
DOI: 10.26083/tuprints-00023640

Conference special sessions and workshops

ERF 2021: Workshop on Human-Robot Collaboration & AI for Sustainable Production

ISM 2021: Co-organisation of the workshop on Human-Robot Collaboration & AI for Sustainable Production

I3M 2021: Special session introducing the FELICE project

ERF 2022: Organization of four workshops on robotics for sustainability

FELICE in press

FELICE was featured in the Magazine Austria Innovativ Issue 6-2021 as one of the most promising projects of Austrian Universities of Applied Sciences (German language)

FELICE was featured in the March 2022 issue of the PLATINUM business, research and innovation Magazine (Italian or English language)

https://www.felice-project.eu/resources/dissemination-material/#page-content

FELICE was featured in the September 2021 issue of Shortcuts, the quick-read magazine of the University of Applied Sciences Upper Austria (German language)

FELICE was featured in issue 22 of the Discover Logistics magazine by Fraunhofer IML (German language)

FELICE was featured twice in January 2023 issue 123 of ERCIM news

Journal Publications

Eßer, J., Bach, N., Jestel, C., Urbann, O., & Kerner, S. (2022). Guided Reinforcement Learning: A Review and Evaluation for Efficient and Effective Real-World Robotics. In IEEE Robotics & Automation Magazine (pp. 2–22). Institute of Electrical and Electronics Engineers (IEEE). https://doi.org/10.1109/mra.2022.3207664

Papoutsakis, K., Papadopoulos, G., Maniadakis, M., Papadopoulos, T., Lourakis, M., Pateraki, M., & Varlamis, I. (2022). Detection of Physical Strain and Fatigue in Industrial Environments Using Visual and Non-Visual Low-Cost Sensors. In Technologies (Vol. 10, Issue 2, p. 42). MDPI AG. https://doi.org/10.3390/technologies10020042

Papadaki, A., Pateraki, M. (2023) 6D object localization in car-assembly industrial environment. In Journal of Imaging 2023
DOI: https://doi.org/10.3390/jimaging9030072

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https://www.felice-project.eu/

https://zenodo.org/communities/felice-h2020/

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