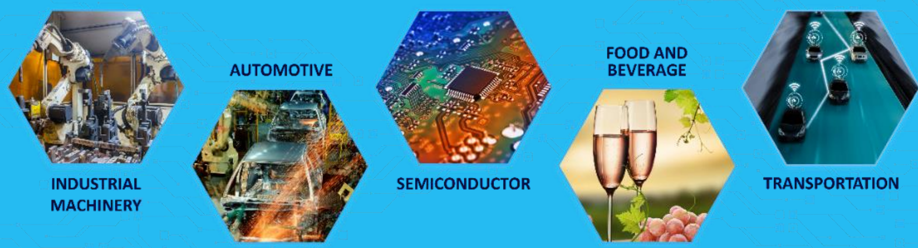
AI4DI Newsletter No.5



Newsletter No.5
August 2022

Cluster I: Robotics
Cluster II: Optimization and Logistics

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As the AI4DI entered the last period of the project, we are more than excited to share with everyone the progress that has taken place so far. With the previous interim report finalised, the time has come to share some concrete project results in the 2022 newsletter series format. In this edition, we are delighted to present you with the demonstrators from the project's robotics, optimisation, and logistics clusters, including the most recent developments and challenges.

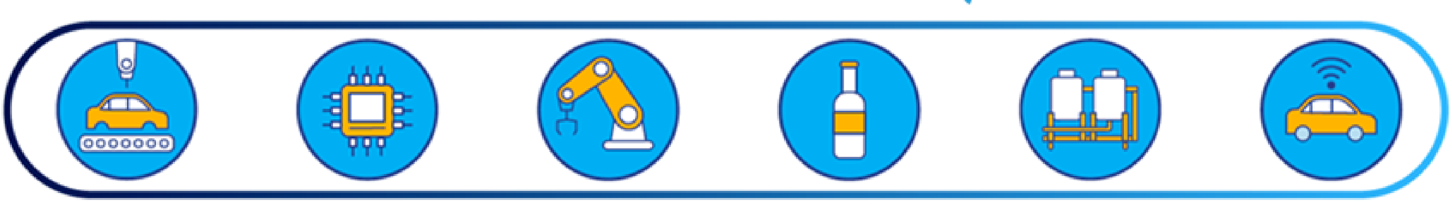
Further on, we are informing you that AI4DI held a technical workshop on 12-13 May 2022. During the workshop, project partners shared their knowledge and progress of the Demonstrators' status.

In addition, we would like to announce that the AI4DI project was recently presented at the EAI4IA workshop on 25-26 July 2022 in Vienna, Austria and will participate at the EAI workshop on 19 September 2022 in Milan, Italy.

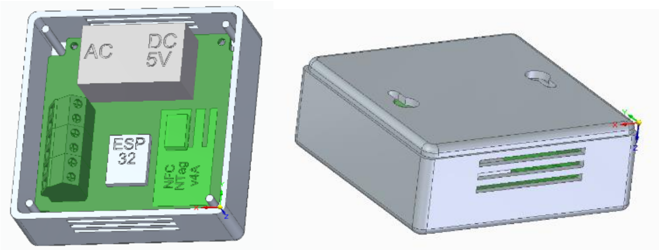
The information on the outcomes of these events will be presented in the subsequent AI4DI newsletter No.6.

The two events are designed to strengthen the synergies between AI4DI and projects TEMPO and ANDANTE, as well as to sustain the dynamic pan-European ecosystem of AI technologies.

ECSEL Joint Undertaking
Electronic Components and Systems for European Leadership



Bluetooth Low Energy (BLE) localization in asset tracking



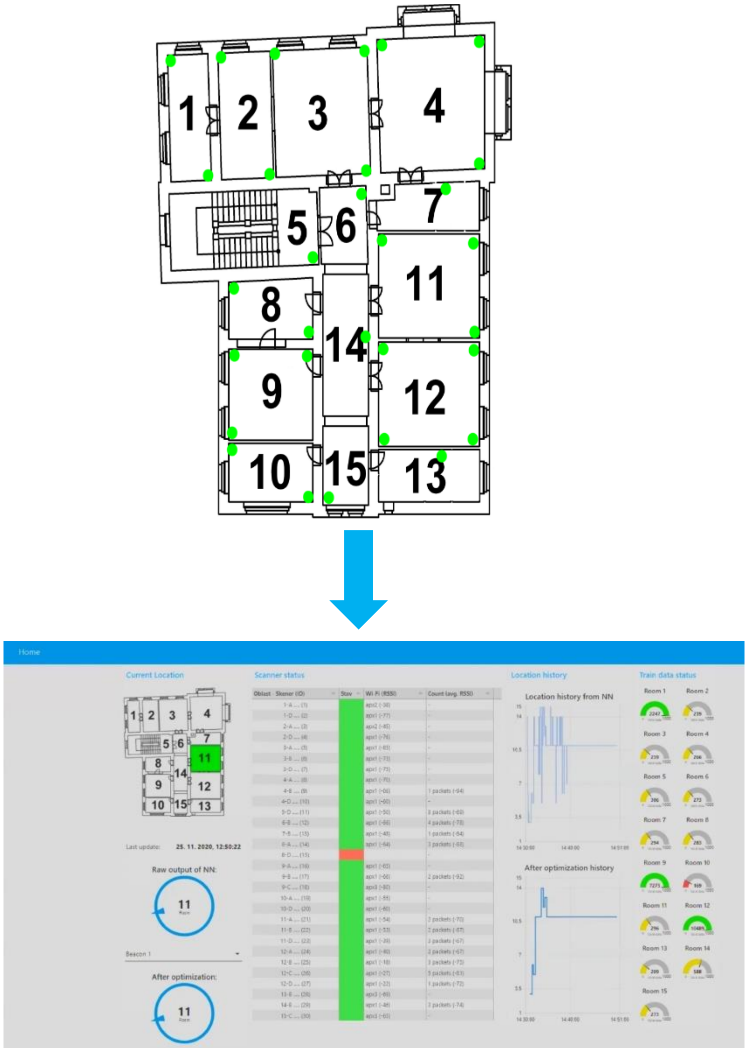
2 images of IMA's second iteration on BLE Locator HW and casing

Indoor asset tracking systems usable for human-machine interaction and asset monitoring at production sites, warehouses, office buildings, etc. can be realized with multiple basic technologies. Institute of Microelectronic Applications (IMA) chose to build upon Bluetooth technology for multiple reasons including its prevalent presence.

The system is based on low power microcontroller units, ARM-based devices, and Bluetooth Low Energy devices with AI-based high-level data processing and position estimation. The localization can be performed with mobile devices compatible with Bluetooth version 4.2 up to the latest Bluetooth 5.2 compliant devices.

The first integration concept was successfully deployed and tested in IMA premises with promising results of the AI layer bringing significant additional value. The AI-based data processing can be entirely performed on the central system unit in form of an ARM-based Raspberry Pi-alike low power device running Linux. The data are visualised live on the first iteration of a web-based graphic user interface.

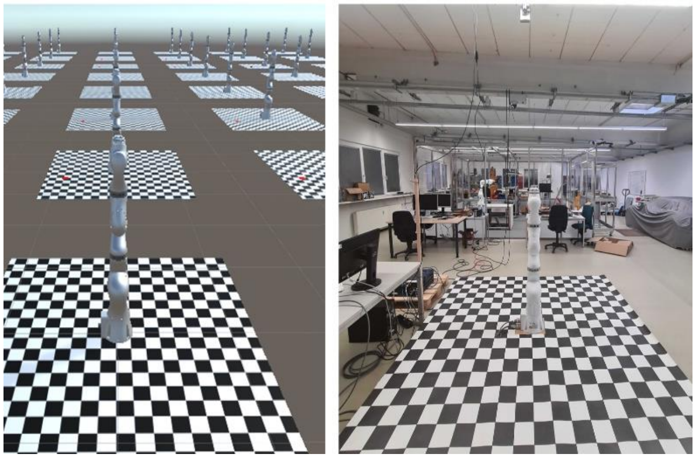
The asset tracking system is based on a network of locators with fixed and known positions communication wirelessly via Wi-Fi with a central processing unit running the ML-based tracking algorithm. The system is also designed with a wide third party BLE-based tags compatibility on the mind.



Floor map with a BLE locator distribution example followed by the live visualization view of indoor asset tracking system GUI.

Technische Universität München

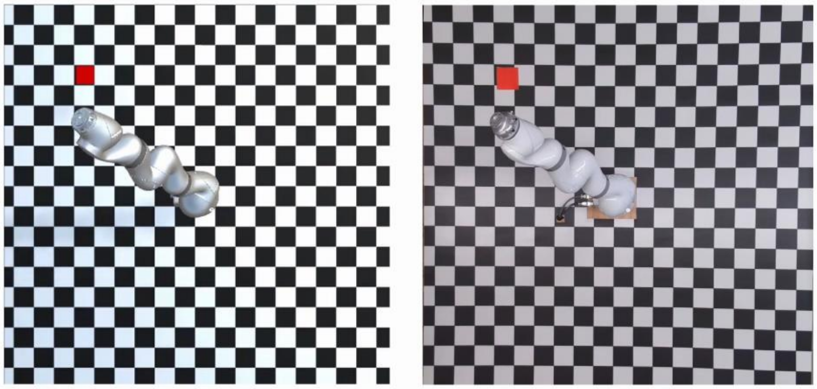
Virtual AI training platform for robot learning



The digital twins in simulation (left) corresponding to a real-world environment in the lab (right)

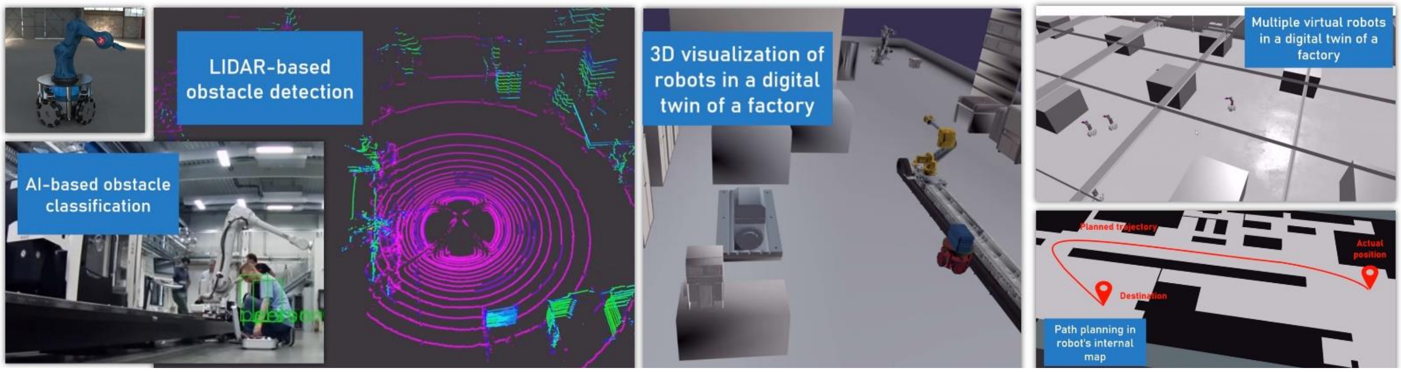
From the beginning of the AI4DI project, at Technische Universität München we have been developing a simulation platform for robot learning, where we can use AI algorithms to train robot controllers for specific industry-relevant tasks, like welding or pick-and-place. The simulations offer many advantages compared to training AI algorithms on real robots, like safe exploration or scaling up the training by gathering experience from thousands of robots. Still, the simulations are always an approximation of the real world, and the AI controllers that learned the task in simulation perform poorly when they are used for the same task on a real robot at the edge, which is known as the “reality gap”. In the last few months, we are actively using the AI controllers trained in simulation on a real robot and exploring ways to enable smooth transfer.

For this purpose, we have a real robot environment and its digital twins in simulation, which enables us to run experiments and objectively evaluate the quality of the transfer. Using different sim2real techniques like domain randomization, continual learning or disturbance observers, we were able to decrease the effects of the “reality gap” and successfully control the real robot with the simulation-trained AI controllers. We are currently working on few publications to disseminate the approaches and the results to the scientific community.



Top view during experimental evaluation of simulation-only trained model in simulated (left) and corresponding real environment (right) for a reaching task.

Autonomous Mobile Robotic Agent



Localization of a robot within the factory; obstacle detection, classification and avoidance; and the visualizations in the digital twin.

The autonomous mobile robotic agent being developed by Brno University of Technology (BUT) in cooperation with Intrasoft International (INTRA) and AUDI mainly focuses on small and middle enterprises, for which the current commercially available solutions of robotic inter-factory transportation are not affordable. This project aims to reach almost plug & play behavior of a robotic system, eliminating expensive and often invasive interventions to the factory hall, which are currently necessary to adapt the environment to the requirements of the mobile robotic transportation system.

The robot will be capable of reliable operation even in complex areas like crowded storage halls with high, narrow, and tortuous lanes, where localization is demanding.

After all, for good throughput is optimized hardware of a robot itself, which is circular-shaped and equipped with omnidirectional wheels maintaining smooth and safe movement in narrow passages.

The researchers have already created a first testing prototype of the robot, which serves to develop and verify AI-based algorithms composing a robot's brain. Such a robot can be launched in a real environment or virtually in a digital twin of a factory, developed by INTRA, into which the current position of real robots can be streamed in real-time.

The current research is focused on the simultaneous operation of multiple robotic agents, which are sharing their knowledge and thus optimizing the overall throughput and reliability of the whole robotic fleet.

The testing robot LOKI during autonomous drive through the factory hall

3D Visualization of final demonstrator of a robot

ELEKTRONIKAS UN DATORZINĀTŅU INSTITŪTS — INSTITUTE OF ELECTRONICS AND COMPUTER SCIENCE · imec · TECHNISCHE UNIVERSITÄT DRESDEN · virtual vehicle · VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

Smart robot with AI-based systems for manipulation with arbitrarily placed objects and intuitive human-machine interaction

Smart Robot demonstrator addresses challenges on how to enable robots to "see", "feel" and interface with humans and the environment around them. Up until now – the final run of the AI4DI project, the Smart Robot demonstrator partners mostly focused on empowering these abilities by the development of respective cognitive sensor modules.

Within the ability to "see", 3D scanning techniques were explored to supplement the synthetic data generation and concept of fast reconfigurability to new tasks. The vision system is being extended to multiple robots, where collaboration between robots will allow to tackle tasks that require different grasping approaches.

In the scope of the ability to "feel" the Sensitive robot skin development activities towards a full-surface touch sensor for robot components were continued. During the last project period, a design variant for a single-curved sensor was elaborated, and the first functional specimens were manufactured and applied to a lower arm of a real lightweight robot.

Smart Robot demonstrator on the Institute of Electronics and Computer Science premises (EDI)

Synthetically generated data with the scanned metal can

Even though the developments within individual use-cases are still ongoing, they have also started to integrate the individual components in one common demonstrator. As covid hampers the initial plans of physical integration, the technologies were adjusted to support a remote approach, whereas the first successful integration results have been already achieved.

Autonomous environment-aware robot


The autonomous environment-aware robot

On this demonstrator, AI4DI partners are working on implementing a method of capturing images and data, using an autonomous robot as a support for cameras and sensors to predict yield or detect dead plants and disease directly in the vineyard.
During the last period, they have fitted their robot with a LIDAR sensor to assess the vigor of the vine plants. They have also integrated cameras into the robot to detect and count flowers and grape clusters and to count and locate dead plants and diseases.

Edge AI is being implemented using a STM32+Coral TPU unit to embark the flower/grape counting in the robot. Performance in the main issue in this step as the devices have limited memory and storage capacities, hence fast processing allows to record only the counting results while discarding the input images.

Data gathering in the cloud is still under study as it depends on the environment (network availability) and the need for real-time results.

Data gathering in the cloud is still under study as it depends on the meteorological condition to find and detect disease. One of these diseases is the mildew that last year has devastated a large part of the inflorescences and led to the defoliation of the plants. Last but not least, the images and models for yield detection were collected. Thus, a model that can classify the different organs of the plant was generated. The main goal for 2022 is to adjust the cameras' estimation to obtain optimal images.

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