DO-IT-YOURSELF KIT FOR LABORATORY AUTOMATION USING THE EXAMPLE OF MEDIA EXCHANGE FOR AN ORGANOID CULTURE

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Background and Basics

- The automation of complex work processes requires specific technical expertise
- Application-specific automation is not economical

Development of a do-it-yourself integration kit

- Implementation by modeling building blocks and no code programming
- Digital twin for individual objects and processes
- Building blocks are generic and parameterizable: the same process can take place on different labware (plates, wells, containers, devices)

Development based on a media exchange process

- In this use case, a liquid handler was built from various individual components
- A mobile robot, a plate reader and an incubator were integrated in a parameterizable way
- The biological process had to continue unaffected
- The DIY automation kit allows code-free integration of automation workflows
- Process modeling with full traceability and changeability of the processes
- This automation kit helps to address with laboratory processes that have not been economic so far

Introduction

- Motivation for automating workflows can be process quality, comprehensive documentation and the relief of laboratory staff
- The aim is to reduce the time to automate and digitalize biological processes through the use of digitalization and modelling tools, such as the digital twin
- Development based on a real example in the laboratory, namely a media exchange process with 96-well microtiter plates
- The biological samples are tempered in the incubator, removed and transported to the plate reader via a mobile robot
- Based on the results evaluated there (e.g. confluence), the plate is transferred to the liquid handler, replacing the used medium with new one (Figure 1)

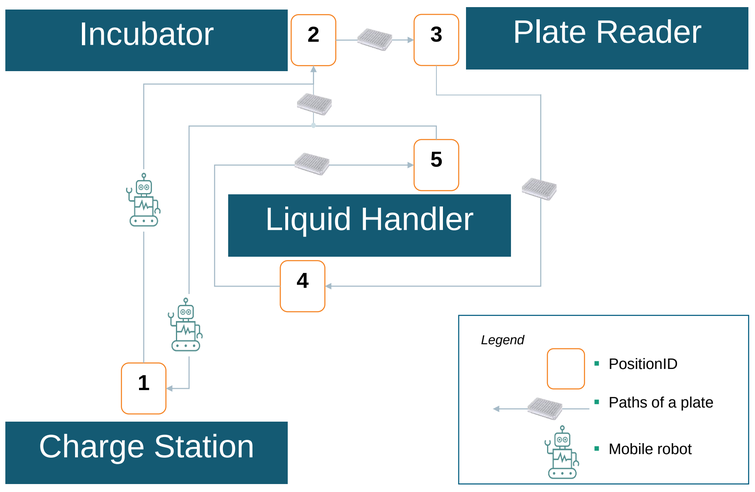

Figure 1: Process flow of media exchange use case in an existing laboratory

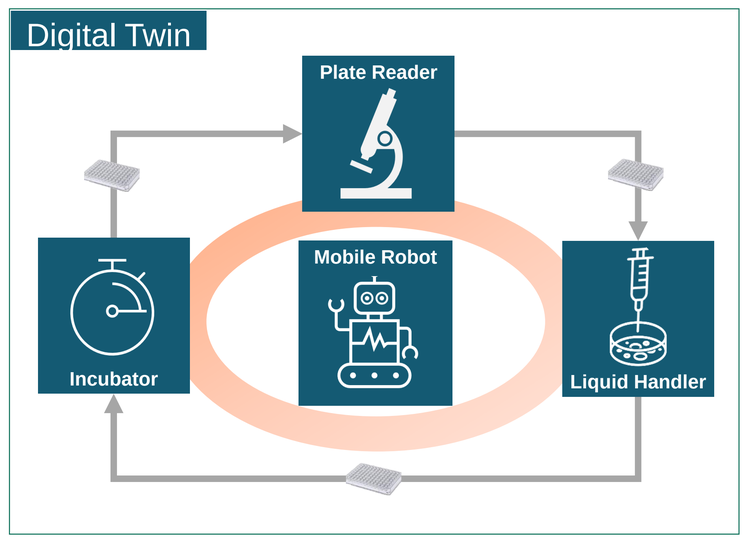

Figure 2: Overview of the equipment used in the digital twin of the media exchange process

Methods

- The individual adaptation of each run of volumes and each well on a plate via parametrization is crucial
- Digital twins of parallel processes, various devices and individual components had to be modeled
- To illustrate a laboratory process, the laboratory equipment was modeled as a digital twin as shown in Figure 2
- The biological process had to continue to function in a real laboratory environment
- The kit should allow to integrate devices that can be digitized and automated
- Process steps and devices should be interchangeable also with manual processes performed by a lab technician

Results

- In this use case, a media exchange process was automated and digitalized with the use of the DIY kit
- A liquid handler was built from various individual components. A “Tecan Cavro Centris“ pump and “Jenny LINAX“ axes were controlled via RS232, RS458 and TCP/IP
- The liquid handler was set up in a clean bench, equipped with an additional sensor for door status to prevent contamination
- In addition to the liquid handler, our mobile robot called “Kevin” and the Cytation Plate Reader ("BioTek-Cytation Gen5") were controlled using SiLA 2 interfaces (developed by Fraunhofer IPA)
- Incoming data is checked regularly and acted upon accordingly
- The software had to stop the process and have the plate transported back to the incubator, in case of contamination risks, to prevent the biological content from degradation
- In addition the DIY kit offers interfaces (via REST, HTTP 2, MQTT, Modbus) to the outside, enabling existing or future software integration

Figure 3: Integrated equipment used as an example for the media exchange use case

Conclusion

- The DIY automation kit allows an integration of automation workflows on different levels without specific technological knowledge. The system is programmed by parameterizing the workflows and transferring them to the technical systems via the process execution engine. In addition to process programming, process modeling is also performed, with full traceability and changeability of the processes.
- Through the diverse interfaces (REST, HTTP 2, MQTT, Modbus, SiLA 2) the kit enables a wide range of existing and future laboratory software and devices. It requires however that these can be digitized.
- The non coding approach enables non-programmer to automate processes, frees staff from standard activities to care added-value ones and allows shorter throughput times with a reduction of defects through optimized process operation.

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