

From Waste to Resource: Leveraging Simulation-based Technologies in the Development of an Autonomous Compost Turner

Max Cichocki*, Eva Reitbauer**, Fabian Theurl**, Christoph Schmied**

Motivation

In recent years, recycling and composting have seen a significant increase of over 80% and with new EU regulations, this trend is expected to continue. Traditional composting methods, which often involve manual labor, are becoming increasingly challenging to sustain within the rapidly evolving landscape of waste management. To address these challenges, intensive research is being conducted by TU Graz and its industrial partners. One major aspect involves the development of an autonomous compost turner, a technology that has the potential to reduce manual labor and increase efficiency in the composting process. With these developments, TU Graz aims to ensure the continued growth and sustainability of recycling and composting practices, ultimately contributing to a cleaner and greener environment.

Results & Outlook

Within this study, subsystems for an autonomous compost turner were successfully developed using simulation-based technologies. The result was an increase in efficiency in all stages of the composting process. In the first phase, processes and interfaces were developed on a Soft-PLC and then transferred to the real hardware. In Phase 2, the PLC was integrated into an IIoT module, and a virtual model of the compost turner was created within ROS. Both systems were combined in a Hardware-in-the-Loop simulation to test the IIoT module's functionality, including control tasks and processing of compost data. In the final phase, the IIoT module was integrated into a prototype autonomous compost turner and the overall system was evaluated in an industrial environment.

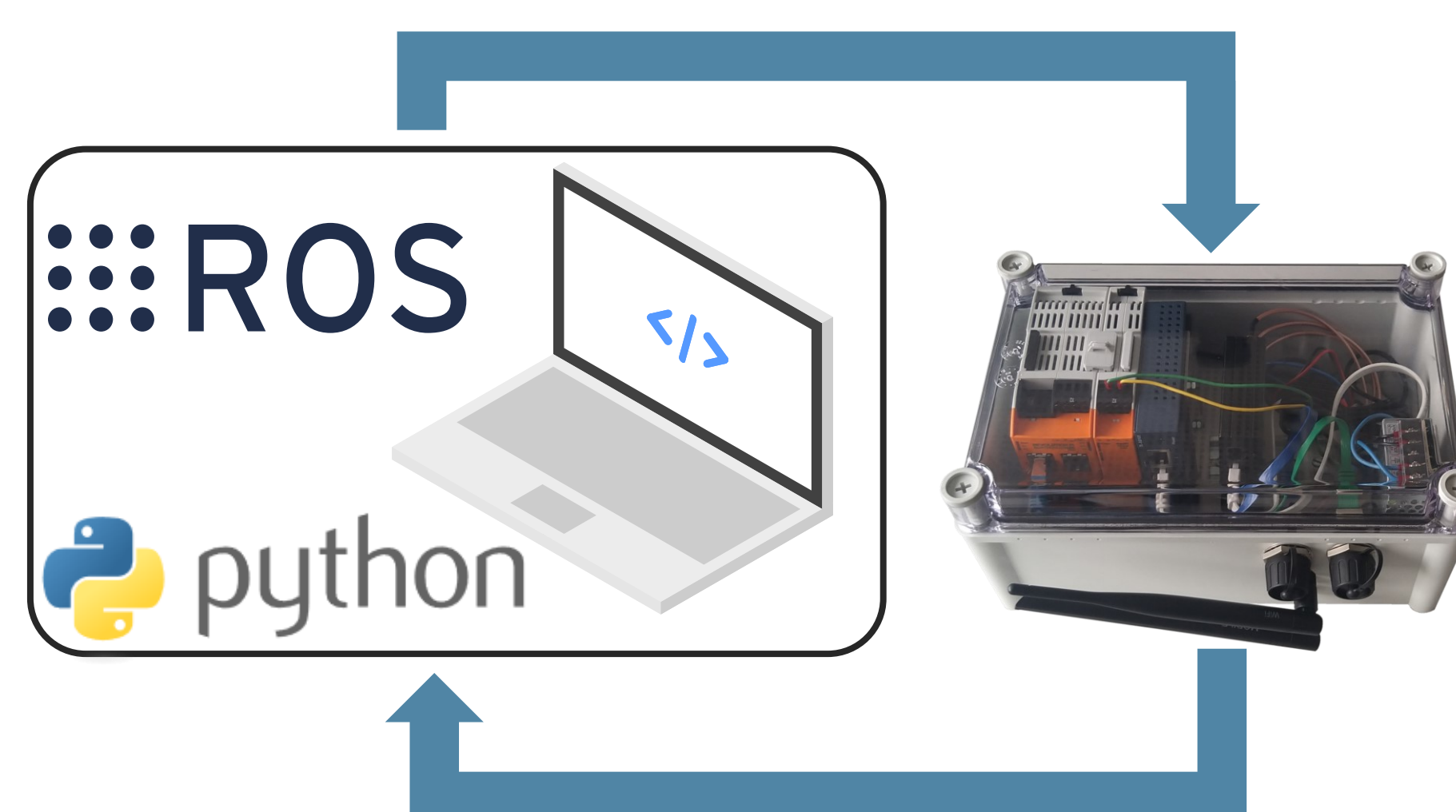
Framework, Methods and Tools

Phase 1: Programmable Logic Controller (PLC) Development



Processes and interfaces are developed virtually on a soft PLC and are only transferred to the real hardware when a defined degree of technical readiness has been achieved.

Phase 2: Hardware-in-the-Loop Simulation



The PLC is integrated into an Industrial-Internet-of-Things (IIoT) module with advanced compost data processing and cloud-based visualization capabilities. The IIoT device is thoroughly tested in a hardware-in-the-loop simulation, using a digital compost turner model within the Robot-Operating-System (ROS) that accurately replicates its physical behavior.

Phase 3: Industrial Testing & Application



Demonstration with a prototype autonomous compost turner within an industrial setting: Showcasing the successful interaction of the IIoT module, the navigation module, the sensor technology and the drive train.

Contact

* Institute of Logistics Engineering, Graz University of Technology, Austria

** Institute of Geodesy, Graz University of Technology, Austria

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