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STATUS ON CONTINUOUS SCANS AT BESSY II

TUPDP013

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ABSTRACT: Continuous energy scanning is an important feature for many beamlines at BESSY II. In 2015 this method was used at 11 undulator and 6 dipol beamlines.[1] Since then demand for this feature - especially among new build beamlines – increased; while the availability of the used hardware decreased. In order to tackle this problem, we investigate alternative hardware and software solutions. By introducing an independent high level controller between the device controllers, we can compensate for communication incompatibilities and increase flexibility.

MOTIVATION

Continuous scanning leads to:

- decreased time an energy scanning experiment takes,
- reduced sample exposure,
- reduced optomechanical vibrations,
- increased beamline experimental portfolio. [2-4]

Since a complete replacement of the currently used hard- and software is neither technically nor economically feasible, we followed the idea of finding an intermediate solution.

The self-imposed goals and requirements were:

- do not introduce new communication protocols, work with what is already there;
- develop a prototype with a high grade of modularity due to the heterogeneous architecture at BESSY II;
- find and patch current limitations in the existing API of the monochromator and undulator motion controller;
- to reduce implementation costs the prototype is implemented as an open-loop system.

The presented prototype was built using a Raspberry Pi 3B+ and two additional CAN extension boards.

PROTOTYPE DESIGN

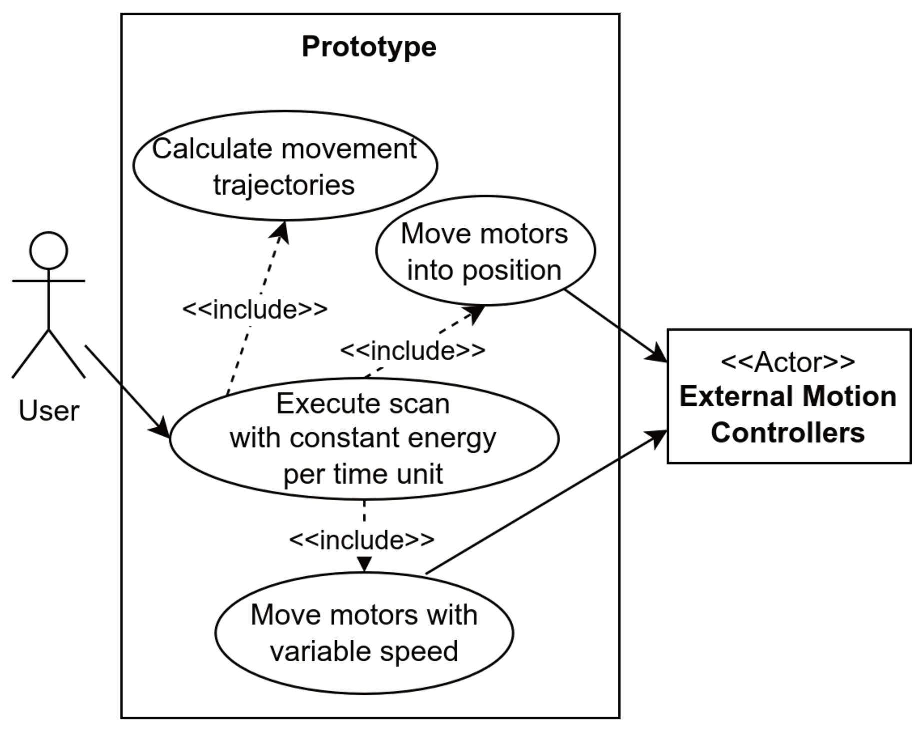

Figure 1: Simplified Use Case Diagram

The user commands the prototype to execute a scan of a specific energy range with constant energy per time unit. Based on the parameters of the user command, the prototype will calculate the movement trajectory and execute it by communicating synchronously with the connected motion controllers.

METHODS

Modularity With Robot Operating System 2 (ROS2)

ROS2 is used to define a modularized software architecture, by separating the software into multiple Nodes.[5]

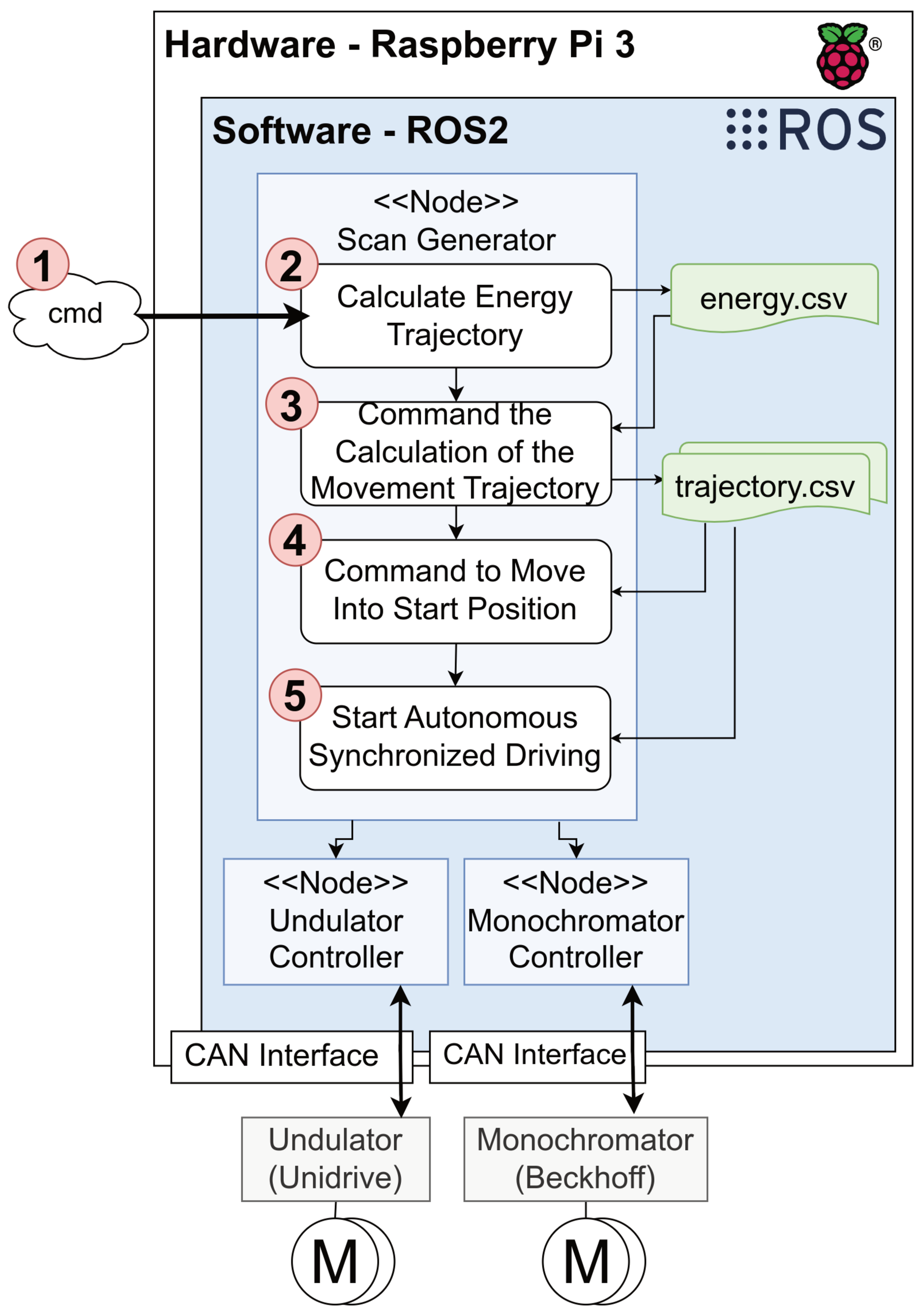

Figure 2: Simplified system architecture [6,7]

Figure 2 shows the steps the prototype executes to perform an energy scan:

1. An outside command to execute a scan in continuous mode is sent to the prototype.
2. The command from step 1 includes the energy trajectory parameter and the names of the controller nodes which should be involved in the driving process. Based on these parameters, the Scan Generator node calculates the energy trajectory and exports it as *energy.csv*.
3. Based on the energy trajectory, each controller node calculates the movement trajectory for their actuator. The generated movement trajectories are exported as *trajectory.csv* files.
4. The controller nodes are commanded to move into start position of the calculated movement trajectory.
5. The system starts the synchronous execution of the speed trajectory.

RESULTS

Example Scan

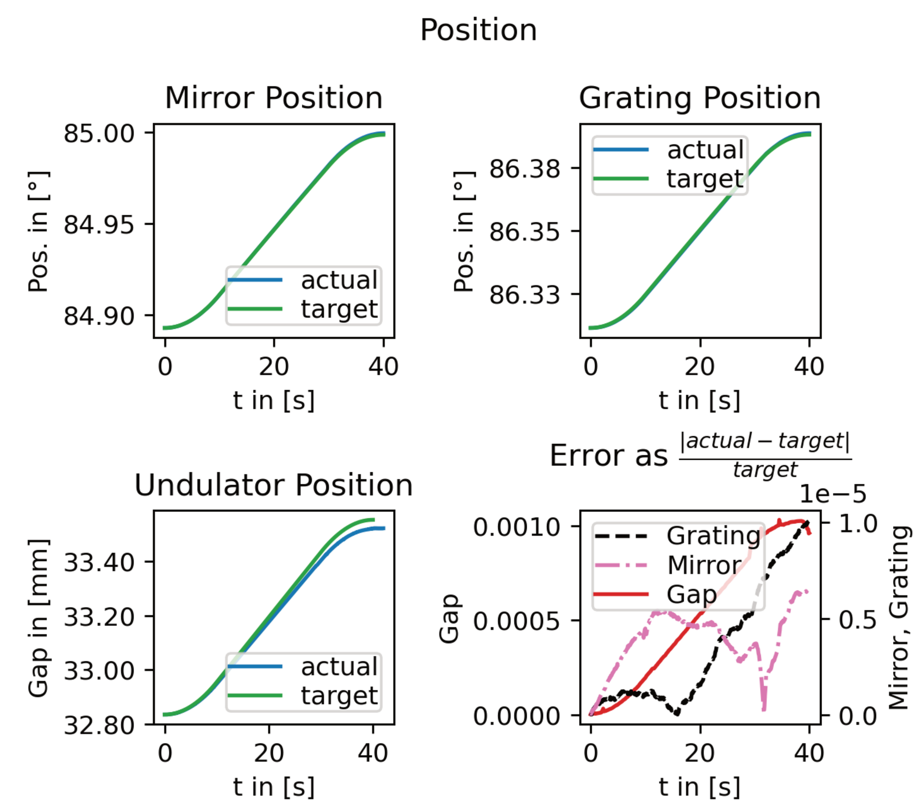

Figure 3: Position logs for a scan of 700-730 eV

Figure 3 shows a scan for an energy range of 700-730 eV, executed in 40 s.

CONCLUSION

- The developed prototype demonstrates successful coordination of multiple actuators at BESSY II beamlines.
- The software design, using the ROS2 framework, promises modularity - allowing extension of the system for additional actuators and sensors.
- Measured by the self-imposed goals, the prototype is seen as a success.
- The undulator and monochromator axles were successfully moved simultaneously with variable speed over time, which is a crucial part of continuous scanning.
- To enhance positioning precision, the system can be expanded into a closed-loop system.

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ACKNOWLEDGEMENTS

We want to thank Dr. Jens Viefhaus and Olaf-Peter Sauer for their steady encouragement during the development of this project.
Special thanks to Edward Rial, Stefan Gottschlich and Stefan Grimmer for providing support during undulator tests and operation.

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