Automatic Configuration of Motors at the European XFEL

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Introduction

Research at the European XFEL scientific facility relies heavily on the use of more than 3000 motors to move components within the various scientific setups. To facilitate flexible experimental setups and to save resources, motors are relocated within the European XFEL and reused at various locations as part of the operation of scientific instruments. Typically, each motor has more than 150 configurable parameters and needs to be configured at each new location. In this contribution, a software tool for the automatic configuration of motors is presented, which aims to achieve the following main goals:

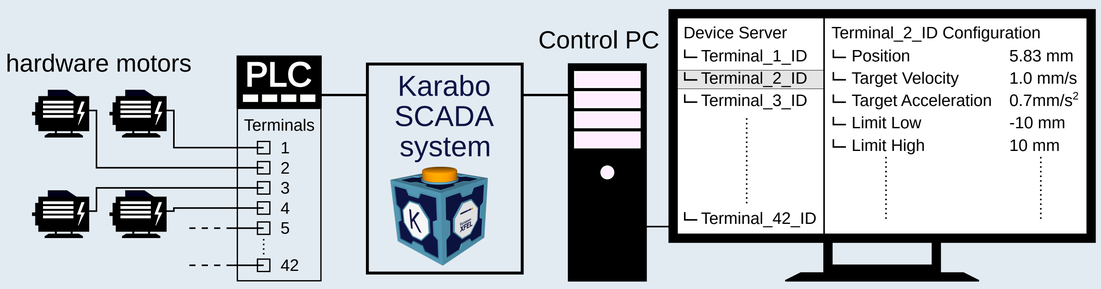
- Minimize time spent by staff to configure motors,
- Minimize mistakes due to manual configuration of motors,
- Protect against hardware damage due to accidental misconfigurations of motors.

The software tool is based on the SCADA system Karabo [1,2], which is developed at European XFEL. Karabo provides a high-performance, reliable, and user-friendly environment to configure and control a plethora of hardware devices. One outstanding feature of Karabo are so-called scenes, easily configurable, multi-purpose graphical user interfaces that can be shipped with Karabo-based software tools. The motor configurator software includes a scene to provide a user-friendly graphical user interface.

Technical background

For the integration of a hardware device in Karabo a software **device class** is written, which provides access to hardware features. Within Karabo, each individual hardware device is represented in terms of an **instance** of the respective device class. For each device instance, a **configuration**, i.e. a set of **operational parameters** for the hardware device, is held by the control system.

Most motors at European XFEL are connected to **programmable logic controllers (PLCs)**, one motor to one PLC terminal. Within Karabo each **PLC terminal** receives a unique identifier, the **terminal ID**. An instance of the correct device class for the connected hardware is automatically created after information about the detected hardware has been forwarded from the PLC to Karabo. Importantly, a configuration is assigned to a terminal ID, but cannot be assigned to the connected hardware directly.



Operational requirements for exp. setups

As motors are relocated between and within experimental setups, the assignment of motors to PLC terminals is subject to changes due to motors being

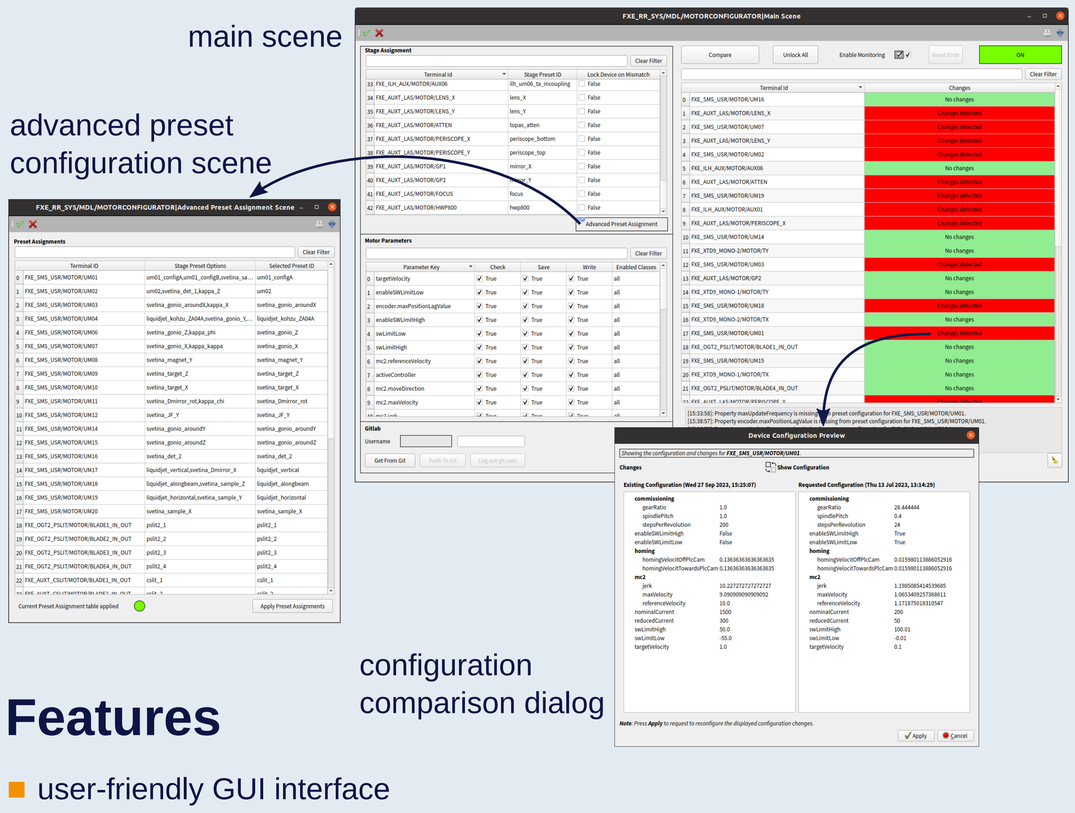
- reassigned to different PLC terminals,
- added to or removed from the setup.

Even if a motor driver of the same type as the previous setup is connected to a PLC terminal, the previous configuration for the PLC terminal in Karabo might not be suitable due to a motion stage with different mechanical and electrical requirements being connected to that driver. Hence, a reconfiguration of the parameters of a terminal ID is necessary upon each exchange of the connected hardware device. Due to the number of motors in a scientific component and the number of parameters in a motor configuration, manual reconfigurations are time-consuming and error-prone.

The Motor Configurator

The motor configurator software tool has been implemented to eliminate the necessity for manual reconfigurations and allows

- to apply stored configuration presets to motors
- monitoring of the configuration of active, i.e. online, motors, including highlighting and displaying deviations from the assigned preset



Features

- user-friendly GUI interface
- a preset configuration is created from the current configuration of a motor
- motor parameters table: select subset of parameters to be saved in preset, restrict configuration comparison to a subset of parameters
- 1-to-1 mapping table to assign stored configurations to terminal IDs
- comparison table: indicate mismatch between current configuration of motor and stored configuration
  - monitoring mode: compare online and stored configurations periodically
  - display differences between stored and online configurations
  - allow to easily apply a stored configuration to a motor
- central database for configurations allows to synchronize stored configurations over multiple installations of the software
  - version control allows to restore previous configurations
  - currently uses git/gitlab as a backend
- preset organization: store multiple different presets for a terminal and select one preset to be used for comparisons with online configurations
- Device 'locking': In case of mismatch between preset and online configuration disable control of motor to prevent motor movements and protect against hardware damage

Conclusion and future work

The motor configurator software tool is heavily used for setting and monitoring configurations of motors at European XFEL. Major benefits of the tool are

- a significant reduction in time needed to configure motor setups,
- a reduced likelihood of motor misconfigurations,
- a reduced likelihood of damage to hardware components.

For convenient modification of existing configuration presets, a configuration editor can be added in future work.

References

[1] Hauf, Steffen, et al. "The Karabo distributed control system." Journal of synchrotron radiation 26.5 (2019): 1448-1461.
[2] https://github.com/European-XFEL/Karabo

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